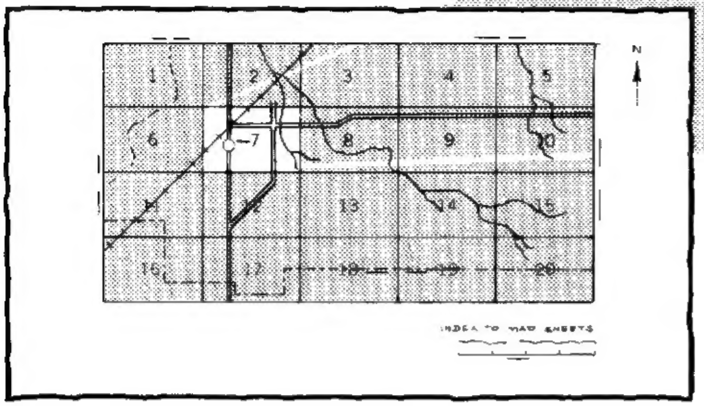
Soil survey of

Otoe County, Nebraska

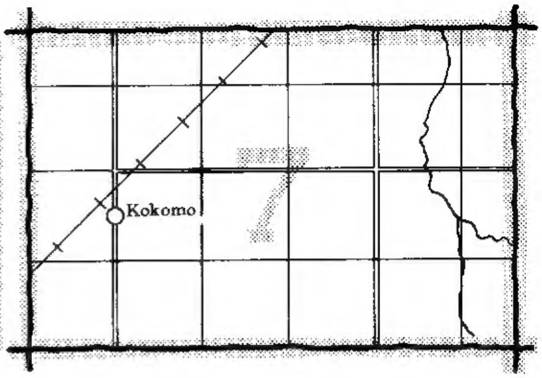
United States Department of Agriculture, Soil Conservation Service
in cooperation with University of Nebraska, Conservation and Survey Division

HOW TO USE

1. Locate your area of interest on the ''Index to Map Sheets'' (the last page of this publication).



2. Note the number of the map sheet and turn to that sheet.



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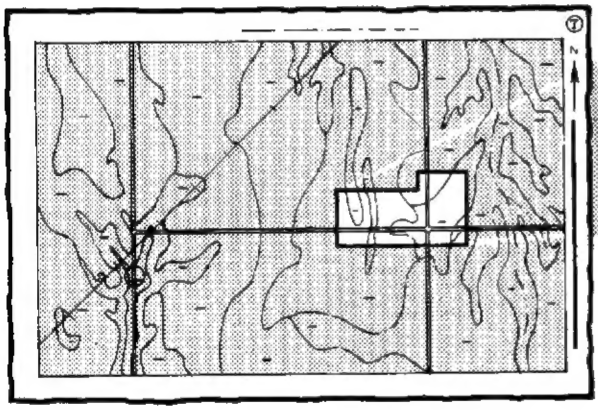

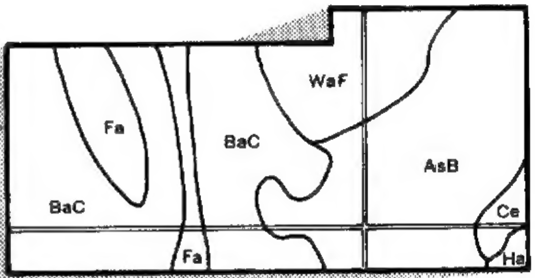

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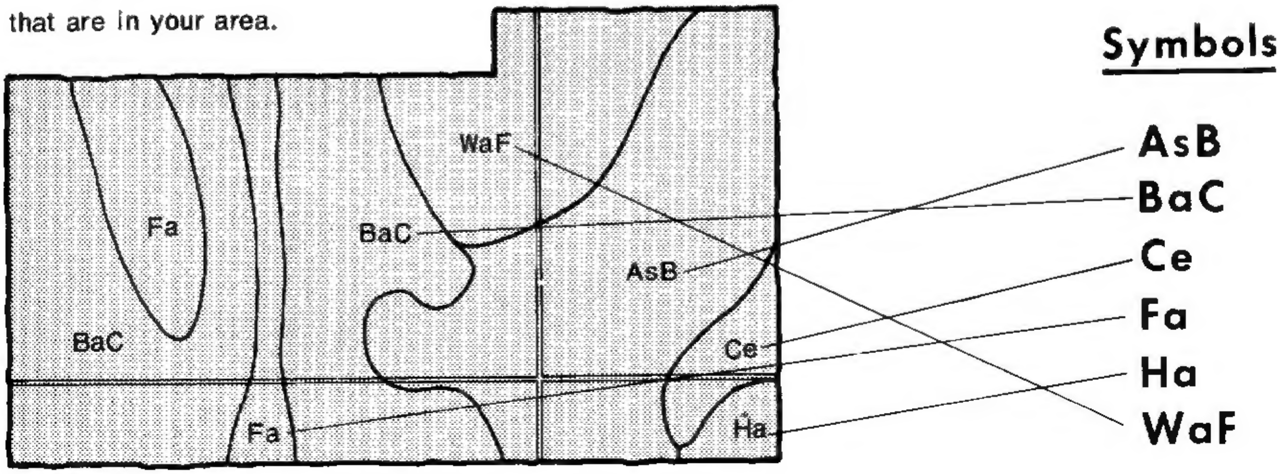
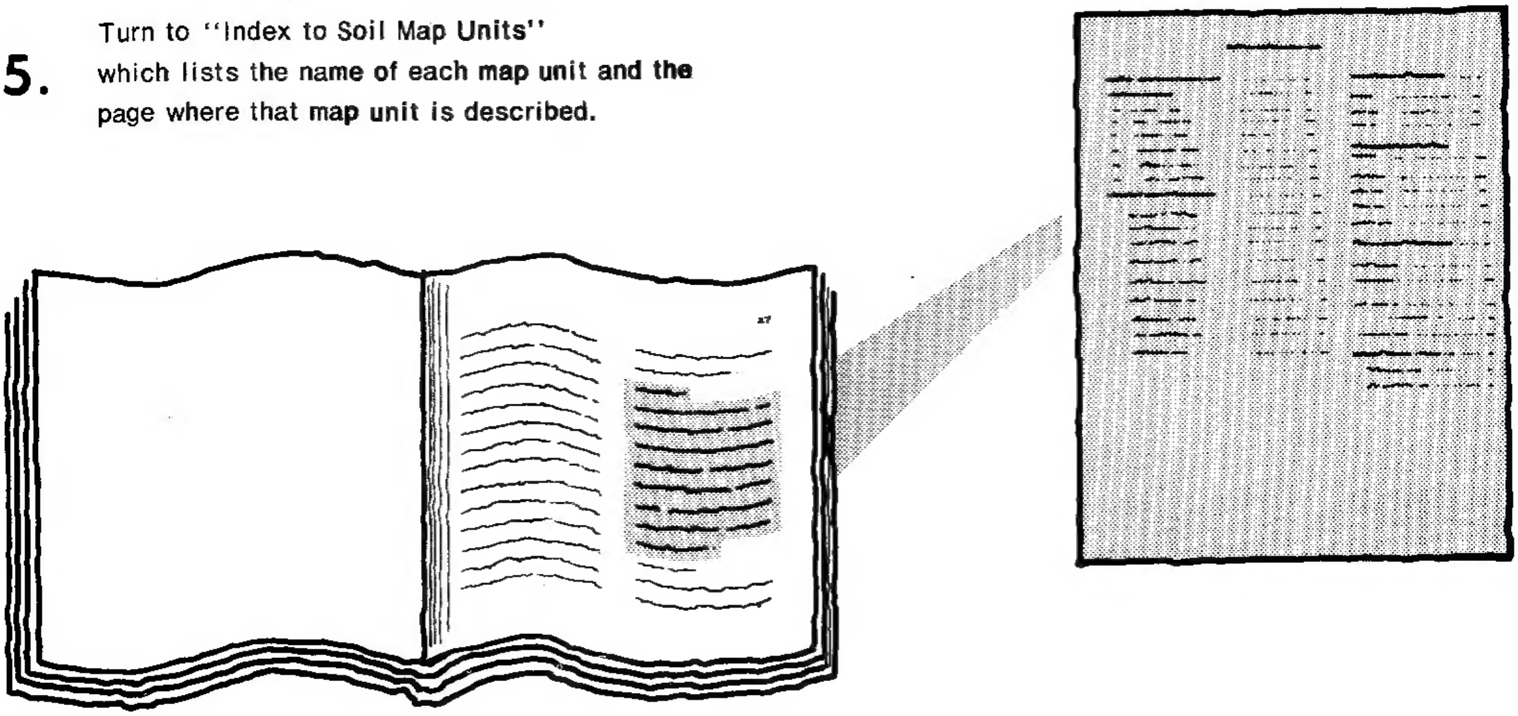
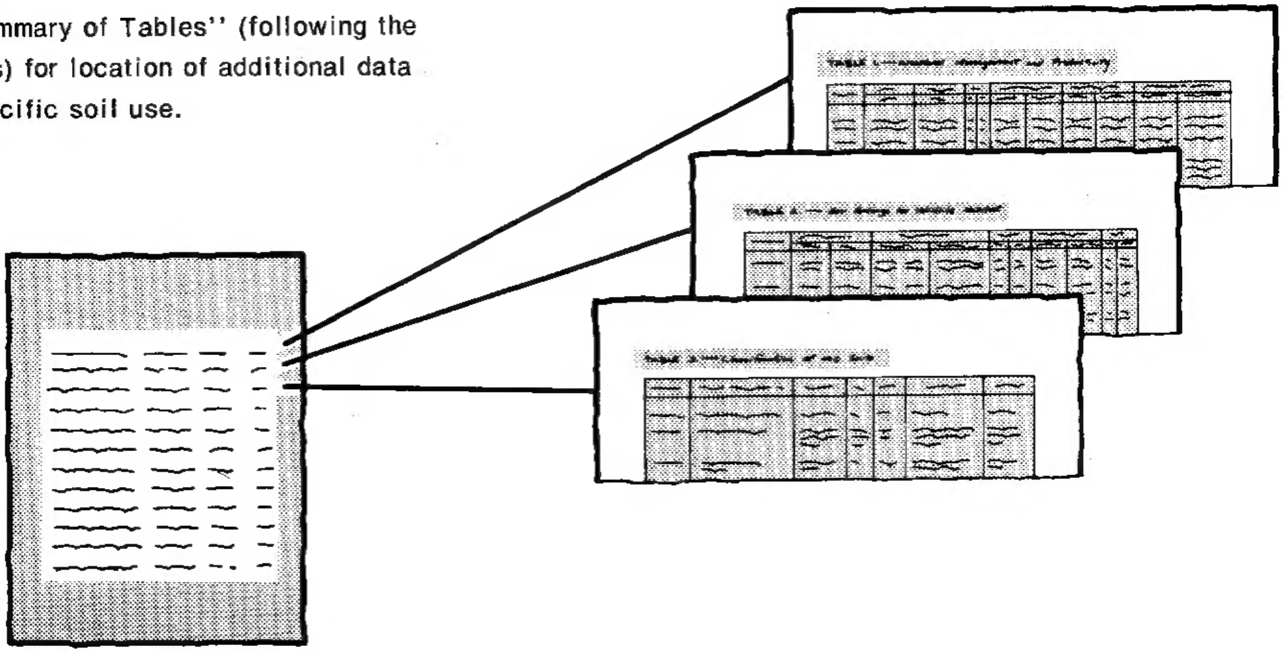


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.



6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.



7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. The University of Nebraska, Institute of Agriculture and Natural Resources, Conservation and Survey Division, has leadership for the state part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

This survey was made cooperatively by the Soil Conservation Service and the University of Nebraska, Conservation and Survey Division. It is part of the technical assistance furnished to the Nemaha Natural Resource District. The Otoe County Commissioners and the Nemaha Natural Resource District provided funds for some of the aerial photography and for the employment of a soil scientist to assist with the soil mapping.

Major fieldwork for this soil survey was performed in the period 1973-78. Soil names and descriptions were approved in 1979. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1979.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

This soil survey supersedes a soil survey of Otoe County published in 1950.

Cover: Contoured fields of corn, oats, grain sorghum, and alfalfa on Wymore silty clay, 2 to 7 percent slopes, eroded.

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soil series

Issued March 1982

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foreword

This soil survey contains information that can be used in land-planning programs in Otoe County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

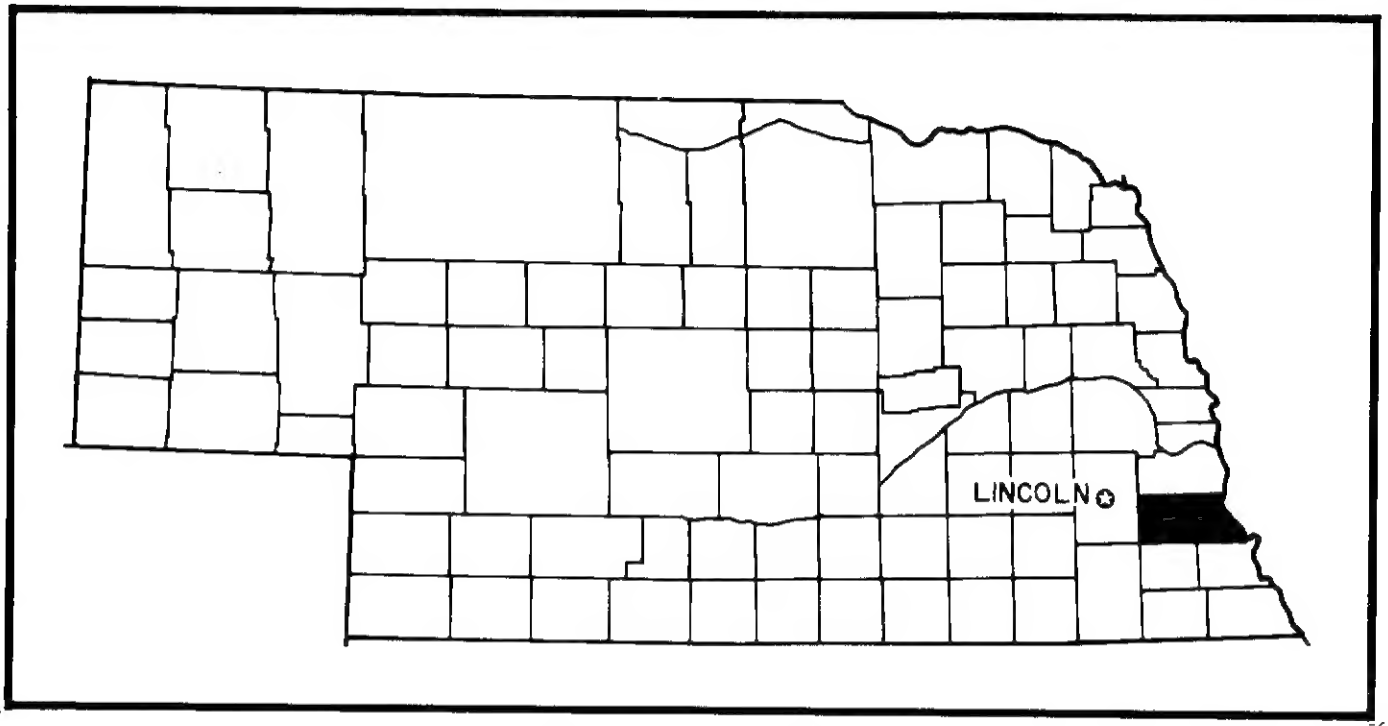
This soil survey is designed for many different users. Farmers, ranchers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

A. E. Sullivan

Albert E. Sullivan
State Conservationist
Soil Conservation Service



Location of Otoe County in Nebraska.

soil survey of
Otoe County, Nebraska

By Howard Sautter, Soil Conservation Service

Fieldwork by Howard Sautter, Soil Conservation Service,
and Dean C. King and Steve M. Peterson, Conservation and Survey Division,
University of Nebraska

United States Department of Agriculture, Soil Conservation Service
in cooperation with University of Nebraska,
Conservation and Survey Division

OTOE COUNTY is in the southeastern part of Nebraska. It is bordered by Iowa on the east, across the Missouri River. The county covers an area of 396,416 acres. Nebraska City is the county seat. The oldest courthouse in the state is in Nebraska City.

Otoe County is part of a dissected glacial plain. The relief ranges from nearly level to very steep. The topography consists of extensive uplands and numerous strips of bottom lands. Most of the county is a succession of rounded ridges, intervening hillsides, and entrenched drainageways. The largest valleys are those of the Little Nemaha and Missouri Rivers.

The climate is continental, and the temperature and precipitation vary greatly from season to season. The climate is suitable for growing common staple crops and grasses.

According to the 1974 U.S. Census of Agriculture, about 72 percent of the acreage of the county is cropland, about 3 percent is woodland, and 16 percent is other farmland. The remaining 9 percent is nonfarmland.

Agriculture is the main economic enterprise in Otoe County. Most farms are of the cash-grain or diversified grain-livestock type. The principal crops are corn, grain sorghum, wheat, soybeans, and alfalfa hay. Minor crops are oats and clover. There are three commercial orchards, chiefly apple, in the vicinity of Nebraska City. Cattle, hogs, and sheep are commonly raised on most farms, and some farms specialize in raising specific breeds of livestock. Horses are kept on some farms.

The major soil on the uplands formed in loess. Other important upland soils formed in glacial material. Water erosion is the principal hazard. Other concerns of management are conservation of water and maintenance of soil structure and fertility.

The soils in the valleys formed in alluvium. Wetness is a problem on some soils, and flooding is an occasional hazard. Maintaining soil structure and drainage are management concerns.

The soils in Otoe County are mainly loamy and clayey and consist of mostly silt-sized and clay-sized particles. Very few of the soils are considered sandy. The soils range from deep to shallow, from well drained to very poorly drained, and from nearly level to very steep.

general nature of the county

This section provides general information about Otoe County. It discusses history and development; climate; physiography, relief, and drainage; geology; water supply; and trends in agriculture.

history and development

The first settlement in what is now Otoe County dates back to 1846 when a military post was established on the present site of Nebraska City. The Kansas-Nebraska Bill in 1854 provided for the establishment of Otoe County. Railroad service in the county began in 1871.

The arrival of more settlers in the 1870's and 1880's increased farming in the county. New roads made towns accessible for services and marketing.

Today, U.S. Highways 73 and 75 and State Highway 50 cross the county from north to south and State Highway 2 crosses the county from east to west. All small communities are linked by paved roads. Railroads traverse the middle and eastern parts of the county. River barges travel the Missouri River and haul grain from Nebraska City to southern terminals.

A few small manufacturing plants are located in the towns of Nebraska City and Syracuse. The plants produce canned goods, meters, bricks, clothing, and glass vials. A coal-powered generating plant is located along the Missouri River a few miles southeast of Nebraska City.

climate

Prepared by the National Climatic Center, Asheville, North Carolina.

Otoe County is cold in winter and is quite hot with occasional cool spells in summer. Precipitation in winter frequently occurs as snowstorms. During the warm months precipitation is chiefly showers, often heavy when warm moist air moves in from the south.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Syracuse, Nebraska in the period 1951 to 1973. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring. Table 3 provides data on length of the growing season.

In winter the average temperature is 26 degrees F, and the average daily minimum temperature is 15 degrees. The lowest temperature on record, which occurred at Syracuse on February 8, 1971, is -23 degrees. In summer the average temperature is 75 degrees, and the average daily maximum temperature is 88 degrees. The highest recorded temperature, which occurred on July 17, 1954, is 109 degrees.

Growing degree days are shown in table 1. They are equivalent to "heat units." During the month, growing degree days accumulate by the amount that the average temperature each day exceeds a base temperature (50 degrees F). The normal monthly accumulation is used to schedule single or successive plantings of a crop between the last freeze in spring and the first freeze in fall.

The total annual precipitation ranges from about 29 inches in the western part of the survey area to nearly 34 inches in the eastern part. At Syracuse, 23 inches, or 70 percent, usually falls in April through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in April through September is less than 19 inches. The heaviest 1-day rainfall during the period of record was 5.75 inches at Syracuse on July 10, 1958. Thunderstorms occur on about 50 days each year, and most occur in summer.

Average seasonal snowfall is 25 inches. The greatest snow depth at any one time during the period of record was 19 inches. On an average of 19 days, at least 1 inch of snow is on the ground. The number of such days varies greatly from year to year.

The average relative humidity in midafternoon is 60 percent. Humidity is higher at night, and the average at dawn is 80 percent. The sun shines 70 percent of the time possible in summer and 60 percent in winter. The prevailing wind is from the south-southeast. Average windspeed is highest, 12 miles per hour, in spring.

Tornadoes and severe thunderstorms strike occasionally. These storms are local and of short duration and result in sparse damage in narrow belts. Hailstorms occur at times during the warmer part of the year in irregular patterns and in relatively small areas.

physiography, relief, and drainage

Otoe County lies within the glaciated part of the Great Plains physiographic province (*4*). It is a dissected glacial plain, but only small remnants of the original till plain remain on the highest divides. The gently sloping to very steep landscape formed through geologic erosion of the glacial plain. Materials have been added and modified by cycles of sedimentation, erosion, and soil formation. Erosion shaped the uplands and the continuous strips of bottom land. The uplands are the most extensive feature of the landscape. The strips of bottom land include the low-lying areas adjacent to streams where soil material was deposited.

Relief ranges from nearly level to very steep. Because of the headward advance of numerous small drainageways, the areas of nearly level uplands are small and, in places, irregular in outline. The rest of the county comprises a succession of ridges, sloping areas, and valleys. The ridges are rounded and gently sloping; the sloping areas range from moderately sloping to very steep; and the valley bottoms are nearly level.

Long, gradual slopes on the north side of stream valleys and short, steep slopes on the south side are features of the uplands. The small drainageways are generally shallow; however, in places, they are sharply cut and have short, steep grades. The steepest slopes in the county are on the uplands. Other steep areas adjoin the bottom lands of some streams. Most of these areas are narrow strips. The bottom lands range in width from a few rods along the smaller streams to nearly 2 miles along the Little Nemaha and Missouri Rivers.

The highest elevation is the upland divide between the Little Nemaha and Big Nemaha Rivers in the southwestern part of the county. The lowest elevation is the southeastern corner of the county along the Missouri River.

Drainage in Otoe County is chiefly southeastward. The county has a number of major and minor streams, each fed by many tributaries. The Little Nemaha River flows

southeastwardly across the central part of the county and receives about 85 percent of the surface runoff. The principal tributaries include the North and South Forks of the Little Nemaha River and the Muddy, Russell, Owl, Silver, Hooper, Brownell, Sandy, and Rock Creeks. Most of the water from the rest of the county is carried eastward directly to the Missouri River by Camp, Four Mile, Walnut, and Table Creeks and northward to Weeping Water Creek by small streams. Nearly all of the rivers and major creeks flow constantly except during prolonged droughts.

geology

In Otoe County, the surface materials are loess, glacial deposits, alluvium, shale, and limestone (*3, 5*). The deep bedrock consists of calcareous shale and limestone of Permian age in the southwestern part of the county and of Pennsylvanian age in the northern and eastern parts. Benfield and Kipson soils are in areas where the shale and limestone bedrock is at the surface.

After the bedrock materials on the surface were buried under glacial material during the ice age, the landscape was one of hills and valleys. After the ice melted, some of the valleys were filled with sand and gravel, and some were filled with clayey material. In Otoe County, the dominant glacial deposit is grayish and clayey and has many fine to coarse sand grains, some pebbles and cobblestones, and a few boulders. Burchard, Pawnee, Shelby, and Steinauer soils are in areas where this deposit is at the surface.

Associated with the clayey glacial deposit are silty, sandy, loamy, and clayey materials. Malcolm soils are in areas of grayish coarse silty material, Dickinson soils are in areas of sandy material, Morrill soils are in areas of brown or reddish brown loamy material, and Mayberry soils are in areas of brown or reddish brown clayey material.

Grayish brown loess is the predominant surface material in the county. It is most extensive in the uplands. Loess consists mostly of silt-sized particles and some clay-sized particles. Dow, Marshall, Monona, Ponca, Sharpsburg, and Wymore soils formed in areas of loess.

The alluvium is mostly silty and clayey material that washed from upland slopes onto the flood plains in the valleys. In the Missouri River flood plain, the material came from outside the area; it is loamy, clayey, and sandy. Colo, Judson, Kennebec, and Nodaway soils are in areas of silty material. Albaton, Onawa, Wabash, Zoe, and Zook soils are in areas of clayey material. Haynie soils are in areas of loamy material, and Sarpy soils are in areas of sandy material.

water supply

Good quality well water is available for use in farm households and for use by livestock in most areas. Large quantities suitable for use in municipalities or for irrigation are limited to certain areas.

Water for individual farms is generally obtained from a perched water table. Wells, 25 to 100 feet deep, are dug in sand lenses of glacial deposits and in sandy alluvium in the stream valleys. Throughout most of the county the amount of water available from these wells ranges from 1 to 10 gallons per minute of continuous pumping. These shallow wells depend on recharge from seepage and percolation of precipitation; therefore, prolonged drought can reduce their output. In areas of shale and limestone, a water supply is difficult to develop. Some water for livestock comes from wells in valley fill and from springs or seeps.

Studies of ground water in Otoe County made by the University of Nebraska, Conservation and Survey Division, in cooperation with the U.S. Geological Survey, have given some information on the availability of ground water. These studies indicate that streams had cut channels in the bedrock before the glaciers advanced across eastern Nebraska. The channels were later filled with glacial material. Where the buried channels contain sand and gravel, wells capable of producing several hundred gallons per minute can be developed, but these areas are limited. The town of Syracuse obtains its water from one of these ancient, deep stream channels located 9 miles south of the town. Large supplies of underground water are also available in the sandy alluvium of the Missouri River Valley. Nebraska City obtains its water from wells in the Missouri River Valley. In recent years, rural water districts have developed well fields in areas where large quantities of water can be obtained. The water is piped to farmsteads.

Nearly all the well water in Otoe County is hard or very hard. It commonly has sulphates and iron in amounts that are objectionable for some uses but are generally not a health hazard to people or livestock.

Ground water can be contaminated by drainage from feedlots, septic disposal systems, spilled chemicals, or other waste materials. Shallow wells are more subject to contamination from wastes than deep wells.

Surface water is an important supplement to the ground water supply in Otoe County. Its use for livestock and recreation extends the limited amount of quality ground water available for domestic use. Streams and ponds that are easily developed are widely used to supply water for livestock. Reservoirs are not used for municipal water supplies.

trends in agriculture

Farming has been the most important enterprise in Otoe County since the county was settled. In earlier years, a large acreage was planted to orchards and to oats, barley, rye, and other small grains because these crops were produced for local use. These crops are now of minor importance. Nevertheless, the kinds of crops

grown and their acreage have been fairly constant through the years. However, the number of farms has declined, and the size of each farm has increased.

The county is expected to remain an important farming area in which most farms will continue as cash-grain farms, livestock farms, or a combination of these.

In 1974, according to the U.S. Census of Agriculture, there were 1,161 farms in Otoe County, and the average size of a farm was 311 acres.

The acreage of the principal crops in 1974 was as follows:

	Acres
Corn harvested mainly for grain	73,090
Sorghum harvested for grain	45,285
Soybeans	35,479
Wheat	30,752
Alfalfa hay	15,169

The number and principal kinds of livestock and poultry in 1974 were as follows:

	Number
Cattle and calves	53,588
Milk cows	2,054
Hogs and pigs	38,861
Sheep and lambs	1,498
Chickens	36,693

The amount of crops and number of livestock raised each year are determined to some extent by weather conditions and prices paid for the products. Nebraska Agricultural Statistics show that in 1977 there were about 16,000 fewer acres in corn harvested for grain than in 1974, but there were 41,000 acres more in grain sorghum, 5,000 acres more in soybeans, and 13,000 acres more in wheat than in 1974. There were about 3,000 fewer cattle and calves in 1977, but there were 13,000 more hogs and pigs.

how this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map units" and "Detailed soil map units."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, rangeland and woodland managers, engineers, planners, developers and builders, home buyers, and others.

This soil survey supersedes the soil survey of Otoe County published in 1950 (*6*). This survey provides additional information and contains larger maps that show the soils in greater detail.

general soil map units

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit, or soil association, on the general soil map is a unique natural landscape. Typically, a soil association consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one association can occur in other associations but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one association differ from place to place in slope, depth, drainage, and other characteristics that affect management.

soil descriptions

1. Wymore association

Deep, nearly level and gently sloping, moderately well drained clayey and silty soils that formed in loess on uplands

This association consists mainly of soils on ridges and side slopes on some of the highest uplands in the county (fig. 1). The ridges and side slopes are uneven in width and length and in percent of slope. The slope ranges from 0 to 7 percent. There are some nearly level divides in the association. Several small waterways drain the areas.

This association makes up about 34 percent of the county. It is about 85 percent Wymore soils and 15 percent minor soils.

Wymore soils are moderately well drained. They have a surface layer of very dark brown silty clay or silty clay loam. In many areas, these soils are eroded, and the subsoil is at the surface. The subsoil, in the upper part, is very dark grayish brown and dark grayish brown, mottled silty clay. In the lower part, it is grayish brown, mottled silty clay loam. The underlying material is grayish brown, dark yellowish brown, and olive gray, mottled silty clay loam.

Colo, Judson, Mayberry, Morrill, Nodaway, Pawnee, and Sharpsburg soils are the minor soils. Judson soils are on foot slopes. Mayberry, Morrill, and Pawnee soils are on hills downslope from the Wymore soils. Nodaway and Colo soils are nearly level on bottom lands in the narrow valleys of upland drainageways. Sharpsburg soils are in positions similar to those of Wymore soils.

The soils in this association in most areas are used for cultivated crops. In some small tracts they are planted to tame grasses. The major crops are grain sorghum, wheat, corn, and soybeans. Alfalfa and clover are also grown.

The soils have high potential for cultivated crops and pasture grasses.

Erosion is the principal hazard. Maintaining the content of organic matter and soil structure and selecting crops that are best adapted to the soils and climate are also concerns in management. Complete conservation management should include terraces, contour farming, grassed waterways, and conservation tillage.

Growing cash crops and feed crops and raising livestock are the main agricultural enterprises. In most places, the supply of ground water is limited but is generally adequate for domestic use. Rural water districts supply some farms with water through pipelines. Some farm ponds have multiple uses, including erosion control, watering of livestock, and recreation.

Most roads are unpaved but are graded, and some are surfaced with crushed rock. Most of the cash grain and other produce is marketed locally and then shipped to larger terminals.

2. Pawnee-Morrill-Shelby association

Deep, gently sloping to steep, moderately well drained to somewhat excessively drained clayey and loamy soils that formed in glacial deposits on uplands

This association consists mainly of soils on hills above numerous drainageways and streams (fig. 2). The slope generally ranges from 3 to 30 percent. Some slopes are long and smooth, others are abrupt and steep. There are some gently sloping hilltops. In some areas there are pebbles and a few stones on the surface. Canyons or bluffs where the slope is more than 30 percent are included.

This association makes up about 29 percent of the county. It is about 43 percent Pawnee soils, 10 percent Morrill soils, and 7 percent Shelby soils. Other soils make up the remaining 40 percent.

The Pawnee soils are moderately well drained. They

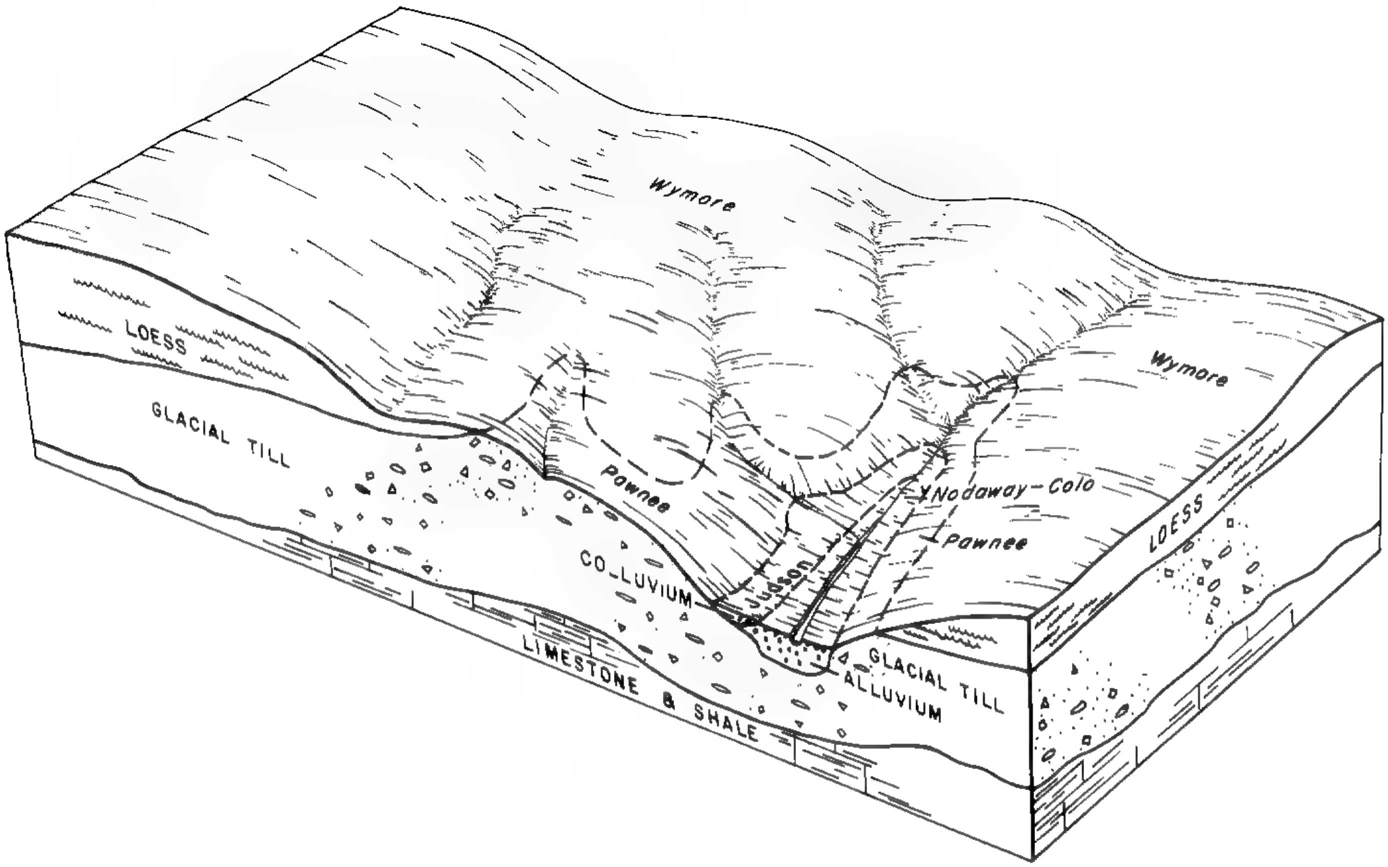


Figure 1.—Pattern of soils, topography, and underlying material in the Wymore association.

are commonly on gently sloping and strongly sloping ridgetops and side slopes above the Morrill and Shelby soils. They are commonly eroded, and the clay subsoil is at the surface. The surface layer is very dark brown clay or clay loam. The subsoil is dark brown and brown, mottled clay in the upper part and dark yellowish brown, mottled clay loam in the lower part. The underlying material is grayish brown, mottled calcareous clay loam.

The Morrill soils are well drained, and they are commonly eroded. They have a surface layer of dark brown clay loam. The subsoil is yellowish red, reddish brown, and brown clay loam. The underlying material is brown, mottled sandy clay loam and sandy loam.

The Shelby soils are well drained and somewhat excessively drained. They are commonly less eroded than the Pawnee or Morrill soils because they are not farmed regularly. They are on hills downslope from the Pawnee soils. Their surface layer is black clay loam. The subsoil is brown and dark yellowish brown clay loam. The underlying material is mottled grayish brown and brown clay loam.

Burchard, Colo, Dickinson, Judson, Malcolm, Mayberry, Nodaway, Steinauer, and Wymore soils are of minor extent in this association. Colo and Nodaway soils are on bottom lands in narrow valleys of drainageways. Judson soils are in high valley areas or on foot slopes. Burchard, Dickinson, Malcolm, Mayberry, and Steinauer soils are closely intermingled with the major soils. Wymore soils are at the higher elevations in the association and on some ridgetops above the major soils.

About 50 percent of this association is used for cultivated crops. The rest is mainly in pasture, although some small tracts are used for hay. Trees grow on some of the steeper slopes. The principal cultivated crops are grain sorghum, wheat, and alfalfa.

The soils in this association have medium potential for cultivated crops and high potential for grasses. They have high potential for wildlife and recreation uses.

Erosion is the principal hazard. Other concerns in management are maintaining fertility and the content of organic matter. Flooding is a hazard on some of the

narrow bottom lands along drainageways. Areas in grass that are used as pasture need grazing control and other management to insure vigorous growth.

The few farms in this association are mainly the combination grain-forage-livestock type. In most places, the supply of good water from wells is limited, but the water is generally adequate for domestic use. Rural water districts supply some farms with water through pipelines. There are a few springs along the drainageways. In places, surface water is collected in farm ponds as a source of water for livestock. Potential sites for dam construction are numerous.

Most of the roads are unpaved but are graded and maintained.

3. Zook-Nodaway-Judson association

Deep, nearly level and gently sloping, poorly drained, moderately well drained, and well drained silty soils that formed in alluvium and colluvium on bottom lands, foot slopes, and stream terraces

This association consists mainly of soils on flat bottom lands on some of the lowest elevations in the county (fig. 3). The bottom lands are nearly 2 miles wide on the lower reaches of rivers but are less than one-half mile wide in the upper reaches of tributary creeks. The slope ranges from 0 to 6 percent. Drainageways dissect the bottom lands. The lower reaches of some creek and river channels have been straightened. The channels are mostly deeply entrenched and have vertical banks. There are gently sloping foot slopes in some places at the base of the uplands.

This association makes up about 13 percent of the county. It is about 27 percent Zook soils, 25 percent Nodaway soils, 18 percent Judson soils, and 30 percent minor soils.

Zook soils are poorly drained. They are commonly in areas some distance from the original main stream channels. The surface layer is very dark brown silty clay loam, the subsurface layer is black silty clay loam and silty clay, and the subsoil is dark gray silty clay. The

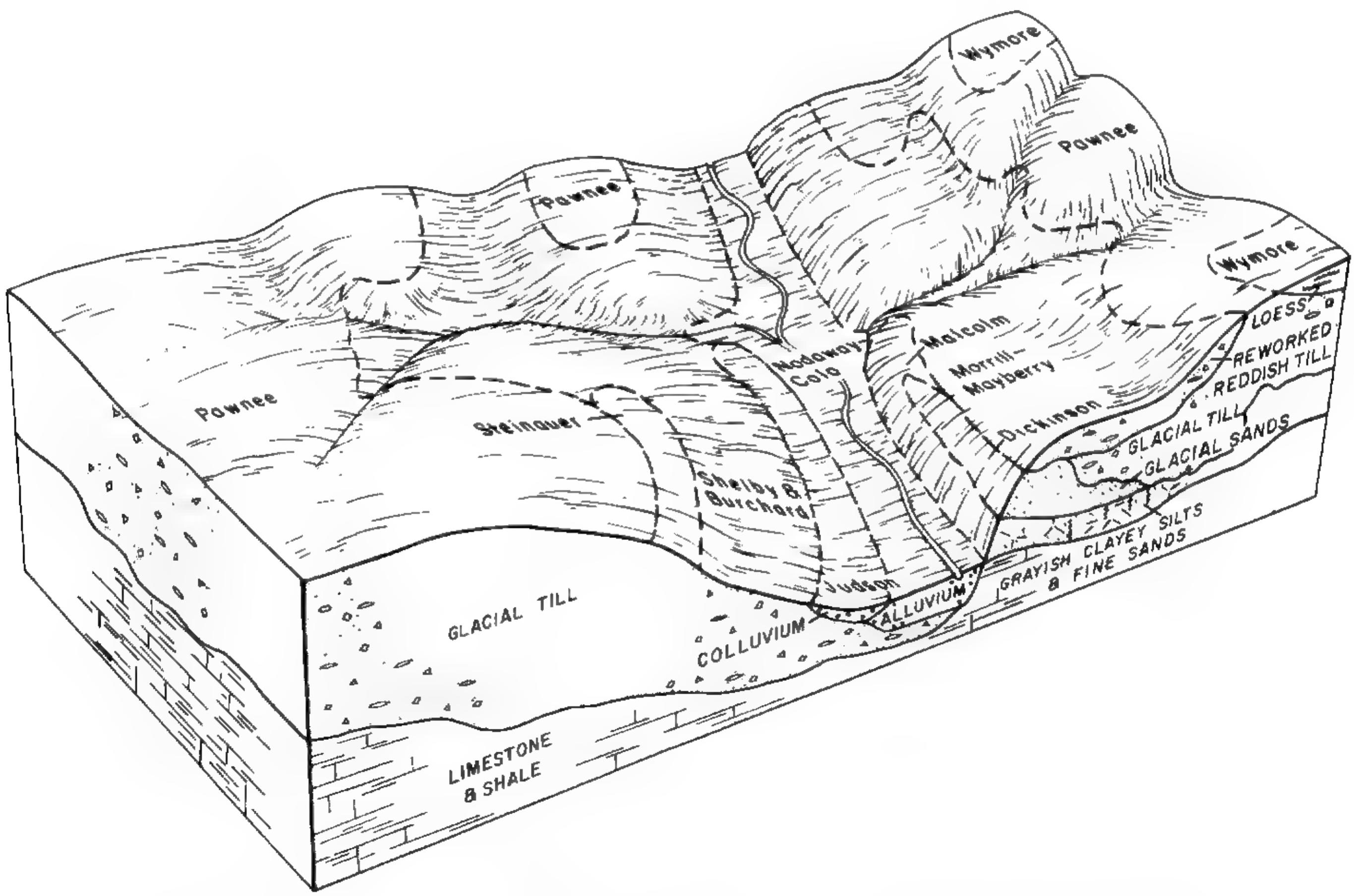


Figure 2.—Pattern of soils, topography, and underlying material in the Pawnee-Morrill-Shelby association.

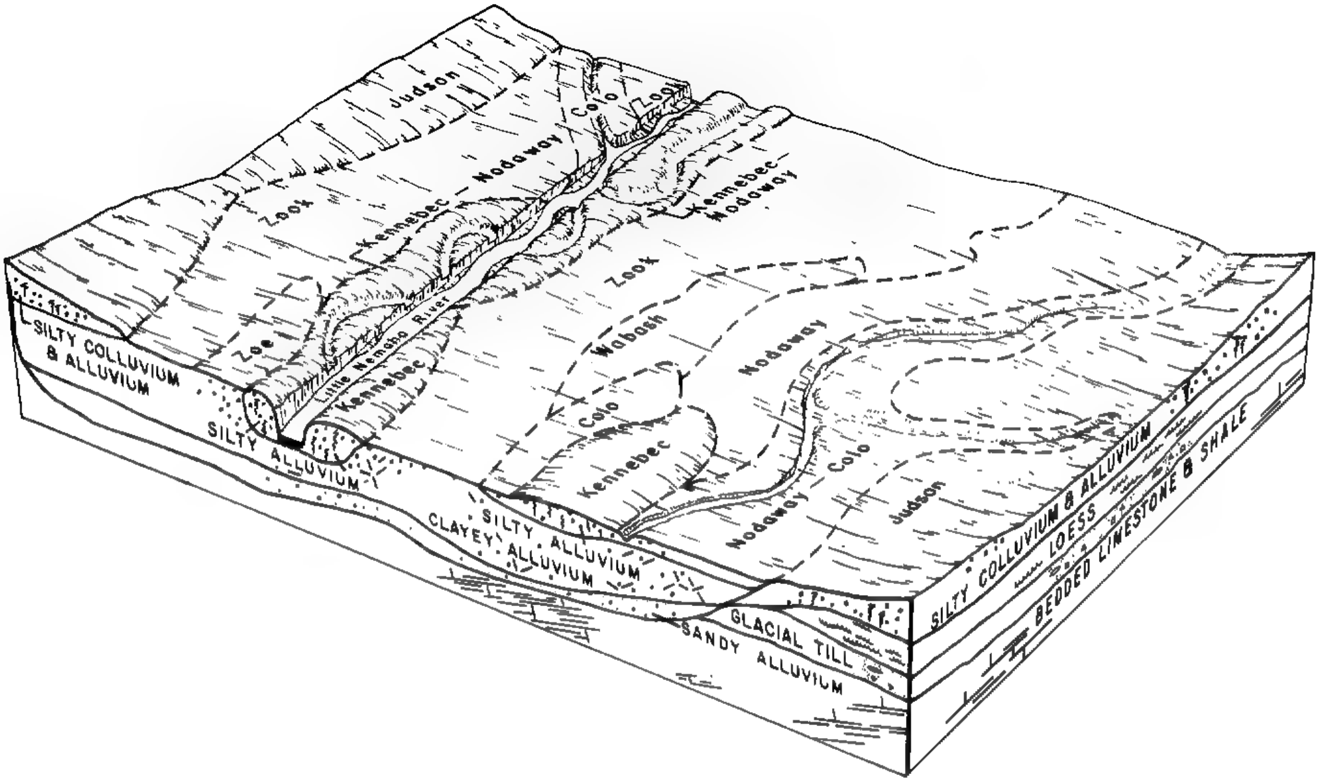


Figure 3.—Pattern of soils, topography, and underlying material in the Zook-Nodaway-Judson association.

underlying material, below a depth of 66 inches, is also dark gray silty clay.

Nodaway soils are moderately well drained and are commonly adjacent to stream channels. They have a surface layer of very dark grayish brown silt loam. The underlying material is stratified, very dark gray and very dark grayish brown silt loam.

Judson soils are well drained. They are on stream terraces and foot slopes at the base of uplands. They have a surface layer of very dark brown silt loam, a subsurface layer of black and very dark brown silt loam, and a subsoil of dark brown and brown silty clay loam. The underlying material is dark yellowish brown silty clay loam.

Colo, Kennebec, Wabash, and Zoe are minor soils. Colo soils are somewhat poorly drained and poorly drained. They are in areas similar to the Zook soils and along the narrower valleys. Kennebec soils are moderately well drained and are in areas adjacent to stream channels. Wabash soils are very poorly drained and clayey. Zoe soils are poorly drained and saline-alkali. Wabash and Zoe soils are at some of the lower elevations in the association.

Nearly all of the acreage in this association is cultivated.

The soils have a high potential for cultivated crops. The principal crops are corn, grain sorghum, soybeans, and wheat.

Wetness and flooding of the soils in spring are the principal concerns in management. Maintaining fertility, soil structure, and the content of organic matter is also a concern.

Farms in this association are either the cash-grain or grain-livestock type. Very few farmsteads and buildings are located in areas of these soils. Water for livestock is obtained from streams, a few springs, and shallow wells. The supply of good ground water from wells is not adequate for irrigation or large municipalities.

Most of the roads are on section lines and are unpaved. There are no roads on many section lines because intersecting stream channels are eroding, and bridges are difficult to maintain.

4. Sharpsburg association

Deep, nearly level to strongly sloping, moderately well drained silty soils that formed in loess on uplands

This association consists mainly of soils on ridges and hillsides on higher uplands. The ridges and hillsides are uneven in width and length and in percent of slope. The slope ranges from 0 to 11 percent. There are some nearly level divides in the association. Several small waterways drain the areas.

This association makes up about 15 percent of the county. It is about 75 percent Sharpsburg soils and 25 percent minor soils.

Sharpsburg soils are on divides, ridgetops, and, most commonly, convex hillsides. The surface layer has been eroded, and the subsoil is near the surface. The surface layer is very dark brown silty clay loam. The subsoil is very dark grayish brown, brown, and grayish brown silty clay loam. The underlying material is grayish brown, mottled silty clay loam.

Colo, Judson, Morrill, Nodaway, Pawnee, and Wymore soils are the minor soils. Colo and Nodaway soils are nearly level on bottom lands in the narrow valleys of upland drainageways. Judson soils are on foot slopes. Morrill and Pawnee soils are on hills downslope from the Sharpsburg soils. Wymore soils are mainly on concave slopes at the head of drainageways.

The soils in this association in most areas are used for cultivated crops. The soils have high potential for all crops commonly grown in the county. The principal crops are corn, soybeans, grain sorghum, and alfalfa. Small acreages are in wheat, oats, forage sorghum, and bromegrass.

Erosion is the principal hazard. Maintaining soil fertility, soil structure, and the content of organic matter are also concerns in management.

The farms in this association are either the cash-grain or grain-livestock type. Well water is limited but is generally adequate for household use. Rural water districts supply some farms with water through pipelines. A few farm ponds are used for watering of livestock.

Most country roads are unpaved. They are graded and follow section lines. A few roads are surfaced with crushed rock. Most of the cash grain and other produce is marketed in Nebraska City and then shipped to larger terminals.

5. Marshall-Monona-Ponca association

Deep, gently sloping to very steep, well drained and somewhat excessively drained silty soils that formed in loess on uplands

The soils in this association are on a succession of ridges, hills, upland drainageways, and narrow valleys (fig. 4). The ridges are rounded, gently sloping, and uneven in width. The hills are uneven in length and percent of slope. The slope ranges from 3 to 70 percent.

This association makes up nearly 7 percent of the county. It is about 50 percent Marshall soils, 15 percent Monona soils, 9 percent Ponca soils, and 26 percent minor soils.

The well drained Marshall soils are on ridgetops and hills. They are gently sloping to moderately steep. The most common Marshall soil is on strongly sloping hillsides and is eroded. The surface layer is very dark brown silty clay loam, and the subsoil is dark brown and brown silty clay loam. The underlying material is dark yellowish brown, mottled silty clay loam.

The well drained and somewhat excessively drained Monona soils are typically hillsides and are steep and very steep. In some places they are on narrow ridgetops. They generally are not eroded. They have a surface layer of very dark grayish brown silt loam and a subsoil of dark brown and brown silt loam. The underlying material is yellowish brown silt loam.

The well drained and somewhat excessively drained Ponca soils are on strongly sloping and moderately steep hills. They are eroded. They have a surface layer of dark brown silt loam and a subsoil of olive brown and light olive brown silt loam. The underlying material, below a depth of 28 inches, is olive gray, calcareous silt loam.

Colo, Dow, Judson, Kipson, Nodaway, and Shelby soils are minor soils. Colo and Nodaway soils are on bottom lands in the narrow valleys of the drainageways. Dow soils are closely intermingled with the Ponca soils. Judson soils are on foot slopes or are in high valley areas. Areas of Kipson and Shelby soils are on the lower slopes of very steep bluffs.

About 70 percent of this association is cultivated. The rest is in grass or trees. Some of the steep areas are cultivated, but most of these areas are used for pasture or as habitat for wildlife. Major crops are corn, soybeans, wheat, and alfalfa.

The gently sloping and strongly sloping soils have high potential for cultivated crops. The steeper soils are scenic and have high potential for wildlife and parkland uses.

Erosion is the principal hazard. Maintaining the organic matter content and fertility are concerns in management. Areas that are used for pasture require grazing control to insure vigorous growth of the grasses.

The farms in this association are the cash-grain or grain-livestock type. They are mainly on ridgetops. Well water is limited but is generally adequate for domestic use. A few farm ponds are used for watering livestock.

Most country roads are unpaved but are well graded. Most roads follow section lines, except in the very steep areas. Most of the cash-grain and other produce is marketed in Nebraska City. It is then shipped to larger terminals.

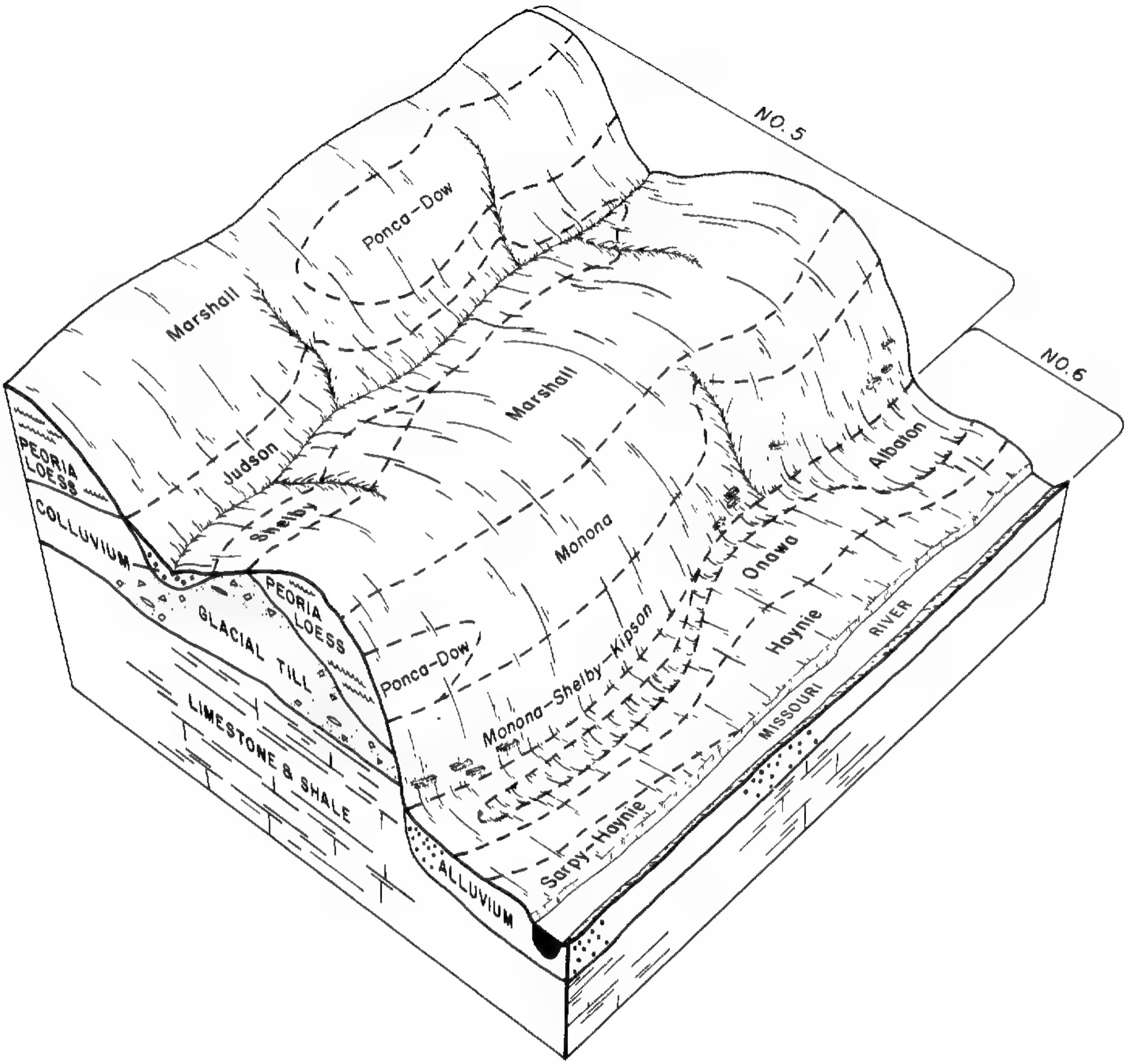


Figure 4.—Pattern of soils, topography, and underlying material in the Marshall-Monona-Ponca association (No. 5) and the Haynie-Onawa-Albaton association (No. 6).

6. Haynie-Onawa-Albaton association

Deep, nearly level, moderately well drained to poorly drained silty and clayey soils that formed in alluvium on bottom lands

This association consists mainly of soils on low bottom lands, half a mile to nearly 2 miles wide, within bends of the Missouri River channel (fig. 4). These areas are subject to flooding. Some areas are slightly undulating, and low places collect water. There are very gentle

slopes along the sides of lakes in old stream channels. The slope ranges from 0 to 3 percent. These soils formed in stratified alluvium. This alluvium is calcareous and has small snail shells and disseminated lime in it.

This association makes up about 2 percent of the county. It is about 40 percent Haynie soils, 30 percent Onawa soils, 20 percent Albaton soils, and 10 percent minor soils.

The Haynie soils are moderately well drained. They are at some of the higher elevations in this association. They have a surface layer of very dark grayish brown silt loam. The underlying material consists of many fine layers of very dark grayish brown, dark grayish brown, and grayish brown silt loam and very fine sandy loam.

The Onawa soils are somewhat poorly drained. They are in positions similar to those of Haynie soils. Onawa soils have a surface layer of very dark grayish brown silty clay. The underlying material, to a depth of about 21 inches, is dark grayish brown silty clay. Below a depth of 21 inches there are many fine layers of grayish brown silt loam and very fine sandy loam.

The Albaton soils are poorly drained. They are at the lower elevations in this association. They have a surface layer of very dark gray silty clay. The underlying material, to a depth of 60 inches, is also silty clay. It is very dark gray, dark grayish brown, and olive gray.

Oxbow areas of old stream channels that are often ponded make up a small part of the association. Sarpy soils are of minor extent in this association. They are mainly in slightly elevated areas along the edges of old stream channels.

About 75 percent of this association has been cleared of trees and is used for cultivated crops such as corn and soybeans. The rest is in grass, shrubs, or trees and is mainly wildlife habitat. Some cottonwood timber is harvested.

The soils in this association have medium to high potential for cultivated crops and for raising cottonwood timber. They have high potential for use as wildlife areas. The soils are suited to many kinds of grasses, shrubs, and trees.

Flooding is the principal hazard. Another concern in management is drainage because of the low elevation and high water table.

The soils in this association are generally not suitable for building site development and sanitary facilities.

There are very few farms and roads in this association. Underground water of good quality is generally abundant.

detailed soil map units

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil and gives the principal hazards and limitations to be considered in planning for specific uses.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the underlying material, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the underlying material. They also can differ in slope, stoniness, salinity, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Sharpsburg silty clay loam, 0 to 2 percent slopes, is one of several phases in the Sharpsburg series.

Some map units are made up of two or more major soils. These map units are called soil complexes or undifferentiated groups.

A *soil complex* consists of two or more soils in such an intricate pattern or in such small areas that they cannot be shown separately on the soil maps. The pattern and proportion of the soils are somewhat similar in all areas. Nodaway-Colo complex, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils in a mapped area are not uniform. An area can be made up of only one of the major soils, or it can be made up of all of them. Shelby and Burchard clay loams, 9 to 15 percent slopes, is an undifferentiated group in this survey area.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 4 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

soil descriptions

Ab—Albaton silty clay, 0 to 1 percent slopes. This is a nearly level, poorly drained soil on broad stream bottom lands that is subject to occasional flooding.

Typically, the surface layer is firm, very dark gray, calcareous silty clay about 9 inches thick. The underlying material, to a depth of 60 inches, is very firm, calcareous silty clay. It has mixed colors of very dark gray, dark grayish brown, and olive gray. In a few areas, silt loam, loam, or very fine sandy loam is at a depth between 24 and 40 inches, and, in places, there is sandy material below a depth of 36 inches.

Included with this soil in mapping are small scattered lakes and marshy areas. These areas make up less than 8 percent of the map unit.

Permeability of this soil is very slow. Runoff is slow. The available water capacity is moderate, totaling about 7 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. It contains free lime and is mildly alkaline throughout. The water table ranges from a depth of about 1 foot in wet years to a depth of about 3 feet in

dry years. The soil dries slowly and stays wet during prolonged periods of rain. It becomes very hard when dry.

About half of the acreage of this soil is cultivated, and the rest is in grass or trees. Areas in grass or trees are generally wildlife habitat.

This soil is suited to grain sorghum, soybeans, corn, and forage sorghum. Wetness is the principal limitation. This soil dries slowly in spring. Adjustments in dates for planting and in varieties of crops are necessary in most years. Surface drainage can be improved by using an appropriate row direction for crops and by grading and leveling. Filling of low areas will help water drain from the surface, and, in places, surface ditching may be feasible. Drainage tile can be used to improve drainage if there are suitable outlets. Excessive compaction and tillage should be avoided, particularly when the soil is wet, because compaction further reduces the permeability of the soil. Returning crop residue to the soil improves the content of organic matter and soil structure.

This soil is suited to species of grasses that are tolerant of wet conditions such as reed canarygrass, prairie cordgrass, and tall fescue.

This soil is suited to species of trees and shrubs that are tolerant of wetness. Establishment of seedlings is sometimes difficult during wet years. An effective practice is to delay tilling the soil and planting seedlings until after the soil has begun to dry. Surface drainage can be improved by grading and leveling. Weeds can be controlled by cultivating between the rows with conventional equipment. Appropriate herbicides can be used in the tree rows. Areas near the trees can be roto-tilled.

This soil is not suited to use as building sites, septic tank absorption fields, and sewage lagoons because of flooding and wetness. This soil has limitations for local roads because of its shrink-swell potential, flooding, and low strength. Shrinking and swelling can be reduced by adding hydrated lime to the base material. Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts help protect roads from flood damage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIIw-1 and windbreak suitability group 2W.

Co—Colo silty clay loam, 0 to 1 percent slopes. This is a nearly level, somewhat poorly drained soil on broad bottom lands that is subject to occasional flooding. Areas are about 15 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silty clay loam about 7 inches thick. A subsurface layer is black, friable silty clay loam about 45 inches thick. The underlying material, at a depth of 52 to 60 inches, is dark gray, silty clay loam. In some areas, the soil is calcareous and has free lime in the surface layer and underlying material.

Included with this soil in mapping are seep spots or springs that are mainly near the base of upland slopes. Also included are small areas of Nodaway and Zook soils. Nodaway soils are in slightly higher positions than those of the Colo soil, and Zook soils are commonly in lower positions. The included areas make up 0 to 15 percent of the map unit.

Permeability is moderately slow. Runoff is slow. The available water capacity is high, about 12 inches within a depth of 60 inches. The organic matter content is high, about 5 percent. This soil is high in natural fertility. It is generally slightly acid throughout. The water table ranges from a depth of about 1 foot in wet years to a depth of about 3 feet in dry years. This soil is normally wet in spring. It dries slowly and stays wet during periods of prolonged rain.

Nearly all of the acreage of this soil is cultivated and is planted mainly to grain sorghum, corn, or soybeans. This soil is suited to corn, soybeans, grain sorghum, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, plant diseases, and insects must be controlled. Wetness is the principal limitation of this soil, especially in spring and during periods of high rainfall, and cultivation, planting, and harvesting may be delayed. Surface drainage can be improved by using an appropriate row direction for crops or by grading and leveling. Where feasible, drainage tile can be used to intercept the water table. Excessive compaction and tillage are to be avoided, particularly when the soil is wet. Compaction further reduces the permeability of the soil. Returning crop residue to the soil helps maintain the content of organic matter and soil structure. Areas of this soil that are too wet to be farmed can be seeded to reed canarygrass, prairie cordgrass, and tall fescue for hay.

This soil is suited to species of trees and shrubs that are tolerant of occasional wetness. Establishment of seedlings is sometimes difficult during wet years. Cultivation of the soil and weed control are management concerns. Weeds can be controlled by cultivating between the rows with conventional equipment. Areas near the trees can be roto-tilled or carefully sprayed with appropriate herbicides.

This soil is generally not suitable for use as building sites and septic tank absorption fields because of flooding and wetness. Sewage lagoons can be constructed on fill material. The bottom of the lagoon should be raised above the high water table and diked to protect the lagoon from flooding.

Flooding, high frost action, and low strength are limitations for local roads and streets. To reduce flooding, the roadbed can be built above flood level on suitable, well compacted fill material. Side ditches and

culverts help drain the surface. Damage to roads from frost action can be reduced by crowning the road by grading and by using a gravel moisture barrier in the subgrade. This provides surface drainage. Roads should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIw-4 and windbreak suitability group 2S.

DcD—Dickinson fine sandy loam, 6 to 11 percent slopes. This is a strongly sloping, well drained soil on knolls and short, uneven side slopes of the glacial uplands. Individual areas range from 3 to 20 acres in size.

Typically, the surface layer is very dark brown, very friable fine sandy loam about 12 inches thick. The subsoil is very friable fine sandy loam about 26 inches thick. The upper part is very dark grayish brown, and the lower part is dark grayish brown. The underlying material, to a depth of 60 inches, is yellowish brown loamy fine sand. In a few areas, the surface layer is gravelly loam or gravelly fine sandy loam. In a few areas, the subsoil is loamy fine sand. Also, in small cultivated and eroded areas, the surface layer is thinner and is dark grayish brown loamy fine sand.

Small areas, commonly on knolls, that have a few cobbles and stones on the surface are included with this soil in mapping. These areas make up 0 to 10 percent of the map unit.

Permeability is moderately rapid in the solum and rapid in the underlying material. Runoff is slow or medium. The available water capacity is moderate, generally about 8 inches for a depth of 60 inches. The organic matter content is moderately low, about 1 or 2 percent. This soil is medium in natural fertility. It is slightly acid or medium acid throughout. This soil dries quickly after rain and can be worked within a wide range of moisture content.

Most of the acreage of this soil is in grass and is used as pasture. A few areas are cultivated.

This soil is poorly suited to row crops. Small grains are more adapted.

This soil is subject to erosion and drought if cultivated. Conservation tillage and return of crop residue to the soil help to increase the intake of water, reduce evaporation of soil moisture, and prevent erosion. Terracing and farming on the contour are mechanical practices that help reduce soil erosion. Fertilizer improves the fertility of the soil.

This soil is suited to grasses and legumes. Introduced grasses, such as smooth brome, need fertilization and some system of rotation grazing. Native grasses such as big bluestem, indiangrass, switchgrass, and little bluestem require deferred grazing. Permanent grass effectively produces forage and controls erosion if the grass is not overgrazed.

This soil is suited to species of trees and shrubs that are tolerant of slightly sandy, somewhat droughty conditions. Erosion and lack of moisture are the main hazards in the establishment of seedlings. Cultivating the soil before planting helps store moisture in the soil. Weeds can be controlled by cultivating between the rows with conventional equipment. Areas in the row can be roto-tilled.

Septic tank absorption fields function well, but this soil is a poor filter. Pollution of underground water from septic tank seepage is a hazard. Sewage lagoons must be lined or sealed to prevent seepage. Extensive grading is required to modify the slope and shape the lagoon. Dwellings and small commercial buildings should be designed to accommodate the slope, or the site can be graded. The slope and frost action are limitations for local roads and streets. Cutting and filling are generally needed for a suitable grade. Side banks and ditches can be mulched and seeded to permanent vegetation to prevent erosion. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road and constructing side ditches help provide surface drainage.

This soil is assigned to capability unit IVe-3 and windbreak suitability group 5.

DcF—Dickinson fine sandy loam, 11 to 20 percent slopes. This is a moderately steep, somewhat excessively drained soil on uneven convex slopes of the glacial uplands. Individual areas range from 3 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, very friable fine sandy loam about 10 inches thick. The subsoil is about 22 inches thick. The upper part is mixed very dark grayish brown and dark brown sandy loam. The middle part is yellowish brown sandy loam, and the lower part is strong brown loamy sand. The underlying material, to a depth of 60 inches, is strong brown loose sand. In places, the surface layer is gravelly sandy loam, and the subsoil is very fine sandy loam or loamy fine sand. In a few small areas, the subsoil is stratified; the thin layers are silty clay loam or clay loam and gravelly sandy loam or sand.

Small areas, commonly on knolls, that have cobbles and stones on the surface are included with this soil in mapping. These areas make up 0 to 10 percent of the map unit.

Permeability of this soil is moderately rapid in the upper part and rapid in the underlying material. Runoff is medium. The available water capacity is low, generally about 5 or 6 inches for a depth of 60 inches. The organic matter content is moderately low, about 1 or 2 percent. The natural fertility is medium, and the reaction is slightly acid or medium acid throughout. This soil dries rapidly and is workable within a wide range of moisture content.

This soil is unsuited to cultivation. Steepness of slope restricts the use of machinery. In addition, this soil is subject to severe erosion if cultivated. It is also subject to drought.

Nearly all of the acreage of this soil is in grass and is used mainly as pasture.

This soil is suited to adapted species of permanent grasses. Species that are tolerant of sandy and droughty conditions and have diffuse root systems are the most desirable. Care should be taken to prevent overgrazing. Residue left on the surface of the soil reduces runoff and aids in storing moisture in the soil.

This soil is suited to species of trees and shrubs that are tolerant of sandy and droughty conditions. Erosion and lack of moisture are hazards to the establishment of seedlings. Conifers can be planted in a shallow furrow in sod. Hardwood species can be planted in established tall stubble after the area has been cultivated to a row crop the previous year. Careful use of appropriate herbicides, hoeing by hand, or roto-tilling can be used to control weeds.

This soil generally is not suitable for sanitary facilities because of the moderately steep slope, poor filtering capability, and seepage. The design of dwellings and other buildings should accommodate the slope, or the site can be graded. The steepness of slope and frost action are limitations for local roads and streets. Following the contour or cutting and filling is generally necessary for a suitable grade. Side banks and ditches can be mulched and seeded to prevent erosion. Damage to roads by frost action can be reduced by crowning the road, constructing side ditches, or some other method that provides surface drainage.

This soil is assigned to capability unit VIe-3 and windbreak suitability group 5.

Ha—Haynie silt loam, 0 to 2 percent slopes. This is a nearly level, moderately well drained soil on broad stream bottom lands that is subject to occasional flooding. The areas range from small narrow strips about 10 acres in size to broad areas 100 or more acres in size.

Typically, the surface layer is very dark grayish brown, very friable, calcareous silt loam about 7 inches thick. The underlying material, to a depth of 60 inches, is stratified, calcareous silt loam and very fine sandy loam. It is mostly dark grayish brown, but thin alternating strata are very dark grayish brown, dark grayish brown, or grayish brown.

Included with this soil in mapping are small areas of the clayey Onawa soils at lower elevations and areas of the sandy Sarpy soils at higher elevations. The included soils make up 2 to 10 percent of the map unit.

Permeability of this soil is moderate, and runoff is slow. The available water capacity is high, generally about 11 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. It contains free lime and is mildly or moderately alkaline throughout. This soil dries quickly after rain and can be worked within a wide range of moisture content.

Most of the acreage of this soil is cultivated, but a few areas are in grass or trees and are used as wildlife habitat. In areas that have large trees, some cottonwood timber is harvested.

This soil is suited to corn, grain sorghum, and soybeans. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects should be controlled. Occasional flooding is the principal hazard. In some years, soil blowing is a minor hazard in spring. Diversions and dikes on local flood plains protect this soil from overflow. Conservation tillage and returning crop residue to the soil help improve the water intake rate and maintain the organic matter content and help reduce moisture evaporation and soil blowing.

This soil is suited to grasses and to use as hayland. Suitable grasses are smooth brome, orchardgrass, big bluestem, indiangrass, switchgrass, and reed canarygrass.

This soil is suited to adapted species of trees and shrubs. Seedlings generally survive and grow well if moisture is conserved and weeds are controlled. Weeds and grasses can be controlled by cultivation with conventional equipment between the rows. Roto-tilling or appropriate herbicides can be used in the tree row.

This soil is generally not suited to use as building sites or for sanitary facilities because of flooding. Limitations for local roads are flooding, frost action, and low strength. Roads should be constructed on suitable, well compacted fill material above flood level. Side ditches and culverts help protect roads from damage. Damage to roads by frost action can be reduced by providing good surface drainage. Crowning the road by grading and constructing side ditches help drain the surface. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIw-3 and windbreak suitability group 1.

Ju—Judson silt loam, 0 to 2 percent slopes. This is a nearly level, well drained soil on stream terraces or foot slopes. Areas are 5 to 30 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 8 inches thick. The dark, friable, silty clay loam subsurface layer is about 12 inches thick. It is black in the upper part and very dark brown in the lower part. The subsoil, at a depth of 20 to 45 inches, is friable silty clay loam. It is very dark grayish brown in the upper part and dark brown in the lower part. The underlying material, to a depth of 60 inches, is dark brown silty clay

loam. In some places, the subsoil and underlying material have more clay and are silty clay.

Permeability is moderate. Runoff is slow. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content is high, generally 4 or 5 percent. This soil is high in natural fertility. It is slightly acid or neutral throughout. This soil dries readily after rain and can be worked within a fairly wide range of moisture content.

All of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Under good management, this soil can be cultivated intensively. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases should be controlled. Proper plant population, timely tillage, return of plant residue to the soil, and minimum tillage are effective management practices. Plant residue returned to the soil increases the intake rate of water and maintains the content of organic matter. Soil compaction is reduced by timely tillage or working the soil when it is not too wet.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weedy vegetation controlled or removed. Weeds and grasses between the rows can be controlled by cultivation with conventional equipment. In the tree rows, roto-tilling and appropriate herbicides can be used.

This soil generally is suited to use as septic tank absorption fields. Sewage lagoons must to be lined or sealed to prevent seepage. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by providing surface drainage. Crowning the road and constructing side ditches help drain the surface.

This soil is assigned to capability unit I-1 and windbreak suitability group 1.

JuC—Judson silt loam, 2 to 6 percent slopes. This is a gently sloping, well drained soil on short, somewhat narrow foot slopes at the base of uplands. Areas are about 5 to 60 acres in size.

Typically, the surface layer is about 10 inches thick. It is very dark brown, friable silt loam. The dark, friable, silt loam subsurface layer is about 24 inches thick. It is black in the upper part and very dark brown in the lower part. Below that, the subsoil, extending to a depth of 55 inches, is friable silty clay loam. It is dark brown in the upper part and brown in the lower part. The underlying material is dark yellowish brown and very dark grayish brown, mottled silty clay loam. In some areas on foot slopes below the glacial soils, the surface layer is loam or clay loam. In places, the subsoil is very dark grayish brown. In some areas, the subsoil and underlying material are silty clay.

Included with this soil in mapping are the finer textured, poorly drained Zook soils and the somewhat poorly drained Colo soils in lower positions. The included soils make up 0 to 10 percent of the mapped areas.

Permeability of this soil is moderate, and runoff is medium. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content and natural fertility are high. This soil is slightly acid or neutral throughout. This soil dries readily after rain and can be worked within a fairly wide range of moisture content.

Most of the acreage of this soil is cultivated. Small tracts are used for pasture.

This soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, plant diseases, and insects must be controlled. The principal limitation, however, is the moderate erosion hazard. Minimum tillage, return of plant residue to the soil, and contour cultivation reduce erosion. Terraces and diversion terraces can be used to help control the concentrated runoff from the upland slopes. Proper plant population and timely tillage are good management practices.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and rotation grazing.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weedy vegetation controlled or removed. Cultivation between the tree rows with conventional equipment stores moisture in the soil and reduces weeds and grasses. In the tree rows, roto-tilling and herbicides can be used to control weeds. Planting the seedlings on the contour reduces erosion.

This soil generally is suited to use as septic tank absorption fields. In most places, the slope can be modified for sewage lagoons. Sewage lagoons must be lined or sealed to prevent seepage. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling of the soil. Proper grading, diversion terraces, or other protection from runoff is needed to eliminate surface water damage.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets from high frost action can be reduced by draining the surface. Crowning the road and constructing side ditches help provide surface drainage.

This soil is assigned to capability unit IIe-1 and windbreak suitability group 3.

Ke—Kennebec silt loam, 0 to 1 percent slopes. This is a nearly level, moderately well drained soil on broad stream bottom lands. It is rarely flooded. Areas are about 10 to 100 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 7 inches thick. The dark, friable silt loam subsurface layer is about 35 inches thick. It is black in the upper part and very dark gray in the lower part. The underlying material, from a depth of 42 to 60 inches, is very dark grayish brown silt loam. In some areas, the underlying material, below a depth of 40 inches is dark grayish brown, very dark grayish brown, or very dark gray, friable silty clay loam or firm silty clay.

Permeability is moderate. Runoff is slow. The available water capacity is very high, about 13 inches within a depth of 60 inches. The organic matter content is high, about 5 percent. This soil is high in natural fertility. It is slightly acid or neutral throughout. A perched water table is at a depth of 4 to 6 feet. This soil dries quickly after rain and is workable within a wide range of moisture content.

Nearly all of the acreage of this soil is cultivated.

This soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Under good management, this soil can be cultivated intensively without damage. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases should be controlled. The plant population should be based on the available soil moisture. Timely tillage and minimum tillage are needed. Returning plant residue to the soil increases the intake of water and maintains the organic matter content. Soil compaction is reduced and soil structure is preserved by timely tillage or working the soil when it is not too wet.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weeds are controlled. Weeds and grasses between the rows can be controlled by cultivation with conventional equipment. In the tree rows, roto-tilling and appropriate herbicides can be used.

The use of this soil for sanitary facilities and as building sites is limited by the hazard of rare flooding. The bottom of sewage lagoons should be lined or sealed to prevent seepage. Dikes protect the lagoons from flooding. High frost action and low strength are the main limitations for local roads. Damage to roads by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help drain the surface. Roads can be built on fill material to protect them from flooding. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit I-1 and windbreak suitability group 1.

KnB—Kennebec-Nodaway silt loams, 0 to 4 percent slopes. This map unit consists of nearly level to gently sloping, moderately well drained soils on bottom lands. The soils are in the original channel of major streams whose course has been changed or straightened. Kennebec soil is rarely flooded and Nodaway soil is occasionally flooded. This complex is about 25 percent nearly level Kennebec soil on the edges of the channel slopes, 35 percent gently sloping Kennebec soil on the upper part of channel slopes, and about 40 percent nearly level Nodaway soil on the lower part of channel slopes and in channel bottoms. The areas are long and about 10 to more than 100 acres in size.

Typically, the Kennebec soil has a black, friable silt loam surface layer about 7 inches thick. The subsurface layer is friable silt loam about 30 inches thick. It is black in the upper part and very dark brown in the lower part. The underlying material, from a depth of 37 to 60 inches, is very dark grayish brown silt loam.

Typically, the Nodaway soil has a very dark gray, friable silt loam surface layer about 7 inches thick. The underlying material, to a depth of 60 inches, is dark gray and very dark grayish brown, finely stratified layers of silt loam.

Small lakes in channel bottoms and some streams are included with these soils in mapping. Also included are small areas of steep soils along the sides of channels. Inclusions make up 0 to 5 percent of the mapped areas.

Permeability of these soils is moderate. Runoff is slow to medium. The available water capacity is very high, generally about 13 inches within a depth of 60 inches. The organic matter content of the Kennebec soil is high, about 5 percent, and that of the Nodaway soil is moderate, about 2 or 3 percent. These soils are high in natural fertility. They are slightly acid or neutral throughout. The water table in the Kennebec soil is at a depth of 4 to 6 feet, and in the Nodaway soil it is at a depth of 3 to 5 feet. These soils dry quickly after rain and can be worked within a wide range of moisture content.

Most of the acreage of these soils is cultivated. Small tracts along stream channels are wooded and are used mainly as wildlife habitat.

These soils are suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects should be controlled. The areas are too irregular and steep for gravity irrigation but are suited to sprinkler irrigation. The more sloping soils are subject to erosion. Timely tillage, return of plant residue to the soil, and

conservation tillage are good management practices. Plant residue returned to the soil increases the intake of water, reduces runoff, and maintains the organic matter content. Soil compaction is reduced and soil structure maintained by timely tillage. Using fertilizer and including legumes in the cropping system help maintain fertility. Legumes also help maintain permeability and porosity.

These soils are suited to trees and shrubs. Seedlings of adapted species survive and grow well if moisture is conserved and weeds are controlled. Weeds and grasses between the rows can be controlled by cultivation with conventional equipment. In the tree rows, roto-tilling and appropriate herbicides can be used.

In areas of Kennebec soil at the higher elevations, dwellings and buildings can be constructed on elevated, well compacted fill material to protect them from rare flooding. The Nodaway soil, because it is occasionally flooded, is not suitable for use as building sites. The bottom of sewage lagoons should be sealed because of seepage. Dikes protect lagoons from flooding.

High frost action, low strength, and flooding are the main limitations for local roads. Damage to roads by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches are effective in draining the surface. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts help protect roads from flood damage.

These soils are assigned to capability unit IIw-3 and windbreak suitability group 1.

KpF—Kipson-Benfield complex, 6 to 20 percent slopes. This complex consists of shallow Kipson soil and moderately deep Benfield soil. These soils are strongly sloping to steep and somewhat excessively drained or well drained. They overlie bedrock and are on knolls and short, uneven side slopes of uplands. Limestone or shale fragments are commonly on the surface. This complex is about 50 percent Kipson soil and 50 percent Benfield soil. Kipson soil is commonly in the steeper areas of the landscape. Individual areas are oblong and range from 3 to 30 acres in size.

Typically, Kipson soil has a very dark gray, friable, channery, calcareous silt loam surface layer about 8 inches thick (fig. 5). The surface is covered with flat limestone fragments 3 to 15 inches long. In places, the limestone fragments make up about 15 percent of the surface layer. There is a transition layer of dark grayish brown, friable, calcareous silt loam about 7 inches thick. It contains a few small fragments of limestone. The upper part of the underlying material, from a depth of 15 to a depth of 20 inches, is light olive gray, shaly siltstone that has a few small fragments of shale. The lower part, below a depth of 20 inches, is olive, consolidated silty shale. A few areas have been disturbed by quarrying. Vegetation covers the uneven slopes of the cut and fill material, and a thin, dark surface layer has formed. The material is a mixture of various amounts of shale and rock fragments.

Figure 5.—Profile of Kipson channery silt loam, 6 to 20 percent slopes. This soil has limestone fragments in the upper part of the profile and shale at a depth of about 20 inches.

Typically, Benfield soil has a very dark brown, friable silty clay loam surface layer about 7 inches thick. The subsoil is firm, silty clay about 29 inches thick. It is very dark grayish brown in the upper part and brown in the middle and lower parts. The underlying material, to a depth of 60 inches, is light yellowish brown, silty and clayey shale. A few areas of Benfield soil have a reddish brown subsoil because the underlying clayey shale is reddish.

Permeability of the Kipson soil is moderate. Runoff is rapid. The available water capacity is low, generally about 5 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is medium in natural fertility and contains free lime. It is difficult to work because of the rock fragments and steep slopes.

The Benfield soil has slow permeability. Runoff is medium. The available water capacity is moderate, generally about 6 inches within a depth of 60 inches. The organic matter content is moderate, about 3 percent. This soil is medium in natural fertility. The surface layer of Benfield soil is slightly acid, neutral, or mildly alkaline. Benfield soil is fairly easy to work under optimum moisture content, but it is sticky when wet and hard when dry.

Most of the acreage of these soils is in grass, but small areas along the edges of the map unit are cultivated. A few areas have small shrubs or trees. Most of the areas are used as pasture and some as habitat for wildlife.

The soils are not suited to cultivated crops. They are suited to adapted species of permanent grasses. The shallow Kipson soil produces less forage than the moderately deep Benfield soil. Areas with poor grass cover can be reseeded to adapted species of grasses. Proper grazing use is a management concern. Residue left on the soil surface reduces runoff and aids in storing moisture in the soil.

Trees and shrubs planted on these soils have a fair chance of survival, but they grow poorly. Kipson soil is generally not suited to windbreak plantings, unless species tolerant of a high lime content can be planted by hand. Benfield soil is suitable for windbreak plantings. Lack of available moisture is the principal limitation of these soils. On the Benfield soil, hand hoeing or applying herbicides help to control weeds in the tree row. On the shallow Kipson soil, hoeing by hand helps to control the weeds.

These soils are poorly suited to use as building sites and for sanitary facilities. Shallowness to bedrock, high shrink-swell potential, slow permeability, and steepness of slope are limitations. These soils are generally unsuitable for use as septic tank absorption fields because of the shallowness of the Kipson soil and the slow permeability of the Benfield soil. These soils are generally not suited to use as sewage lagoons because of the shallowness to bedrock and steepness of slope.

Dwellings can be designed without basements because of the shallow depth to bedrock. Foundations for buildings must be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling of the soils. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

Frost action, low strength, and steepness of slope are limitations for roads and streets. Damage to roads and streets by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help drain the surface. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. For roads and streets on these strongly sloping to steep soils, cuts and fills are generally needed for a suitable grade.

These soils are assigned to capability unit VIs-4. Kipson soil is in windbreak suitability group 10, and Benfield soil is in windbreak suitability group 4L.

MaD—Malcolm silt loam, 5 to 11 percent slopes. This is a strongly sloping, well drained soil on side slopes on glacial uplands. Areas range from about 3 to 40 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 7 inches thick. The subsoil is friable silty clay loam about 21 inches thick. The upper part is very dark grayish brown. The middle and lower parts are brown. The underlying material, to a depth of 60 inches, is light brownish gray silt loam (fig. 6). In some areas, the subsoil is brown or reddish brown clay loam.

Included with this soil in mapping are small areas, in similar positions on the landscape, of Dickinson fine sandy loam and the finer textured Mayberry soils. The included soils make up about 2 to 8 percent of the map unit.

Permeability is moderate. Runoff is medium or rapid depending on the use of the soil and the cover on the surface. The available water capacity is high, generally about 11 inches within a depth of 60 inches. The organic matter content is moderate, generally about 3 percent. This soil is medium in natural fertility. It is slightly acid or medium acid throughout. This soil dries readily after rain. It is easily worked within a fairly wide range of moisture content.

Areas of this soil are mostly in grass and are used mainly as pasture. Small areas are cropped to grain sorghum and wheat.

This soil is suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, and forage sorghum. Erosion and loss of moisture through runoff are the principal hazards. If used for cultivated crops, conservation tillage and the return of crop residue to the soil help increase the intake of water and maintain the content of organic matter and soil structure. Terraces, grassed waterways, and contour

Figure 6.—Profile of Malcolm silt loam, 5 to 11 percent slopes. This soil formed under grassland vegetation. The light-colored underlying material at a depth of about 28 inches is silt loam.

farming help control runoff and erosion. This soil can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. The use of fertilizer may be necessary.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, need deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs survive well and grow fairly well on this soil. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil. Cultivating after planting helps reduce plant competition. Roto-tilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour reduces erosion. The plants need to be protected from damage by livestock.

Septic tank absorption fields should be constructed on the contour, and land shaping is generally needed for proper operation of the field. Sewage lagoons are not generally suited to this soil because of slope and the potential of seepage. An alternate site should be considered. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

High frost action and low strength are limitations for roads and streets. Damage to roads and streets from frost action can be reduced by good surface drainage. Crowning the road and constructing side ditches help provide surface drainage. The subbase and surface pavement of roads and streets should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIIe-1 and windbreak suitability group 3.

MaD2—Malcolm silt loam, 5 to 11 percent slopes, eroded. This is a strongly sloping, well drained soil on uneven side slopes on glacial uplands. Areas range from about 5 to 35 acres in size.

Typically, the surface layer is friable, very dark grayish brown silt loam about 5 inches thick. All of the original surface layer and part of the subsoil have been eroded. The subsoil is friable silt loam about 18 inches thick. It is dark grayish brown in the upper part and brown in the lower part. The underlying material, to a depth of 60 inches, is pale brown and light gray, stratified very fine sandy loam and silt loam. In some areas, the subsoil is reddish brown clay loam. In places, the underlying material has thin layers of olive gray silty clay loam.

Included with this soil in mapping are small areas, in similar positions on the landscape, of Dickinson fine

sandy loam, the finer textured Mayberry soils, and a soil that has a few stones on the surface. Included areas make up 5 to 15 percent of the map unit.

Permeability of this soil is moderate. Runoff is medium to rapid, depending on the use of the soil and the amount of vegetation on the surface. The available water capacity is high, generally about 11 inches within a depth of 60 inches. The organic matter content is moderately low, generally 1 or 2 percent. This soil is low to medium in natural fertility. It is slightly acid or medium acid throughout. This soil dries quickly after rain. Workability is good within a fairly wide range of moisture content.

About 75 percent of this soil is in grass, and 25 percent is cultivated. Areas in grass are used mainly as pasture. Some areas have introduced grasses, and some have native grasses. Cultivated areas are cropped mainly to grain sorghum and wheat.

This soil is poorly suited to cultivated crops. It is best suited to wheat, oats, and grain sorghum. Erosion is the principal hazard. Other management concerns are improving the organic matter content, improving fertility, and conserving moisture. If this soil is used for continuous row crops, erosion is difficult to control unless a combination of special practices is used. Conservation tillage and return of plant residue to the soil increase the intake of water, reduce evaporation of soil moisture, add organic matter, and help prevent erosion. Terracing and farming on the contour are mechanical practices that help prevent erosion. Grassed waterways carry runoff from the fields without eroding drainageways. Use of commercial fertilizers improves the fertility of this soil. Rotating row crops, small grains, and legumes is an effective cultural practice.

This soil is suited to grasses. Introduced grasses, such as smooth bromegrass, need fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and sideoats grama, need proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

This soil is suited to adapted species of trees and shrubs. Plant competition and erosion are the principal hazards. Weeds can be controlled by cultivating between the rows with conventional equipment. Roto-tilling and appropriate herbicides can be used for the area in the row. Planting the trees and shrubs on the contour reduces erosion.

Septic tank absorption fields should be constructed on the contour, and land shaping is generally needed for proper operation of the field. This soil is not suited to sewage lagoons because of slope and seepage. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

High frost action and low strength are limitations for local roads and streets. Damage to roads and streets from frost action can be reduced by draining the surface. Crowning the road and constructing side ditches help to provide surface drainage. The subbase and surface pavement should be thick enough to compensate for the low strength of this soil. Coarser grained material can be used for subgrade to insure better performance.

This soil is assigned to capability unit IVe-8 and windbreak suitability group 3.

MaF—Malcolm silt loam, 11 to 25 percent slopes. This is a moderately steep and steep, somewhat excessively drained soil on uneven side slopes on glacial uplands. Areas range from about 5 to 20 acres in size.

Typically, the surface layer is very dark brown, friable silt loam about 7 inches thick. The subsoil is friable silt loam about 26 inches thick. It is very dark grayish brown in the upper part, brown in the middle part, and pale brown in the lower part. The underlying material, to a depth of 60 inches, is very pale brown silt loam. In a few areas, the subsoil is reddish brown loam or clay loam. In places, the subsoil has been incorporated into the surface layer by rodents and burrowing animals.

Included with this soil in mapping are small areas, in similar positions on the landscape, of Dickinson soils that formed in sandy material and areas of a soil that has a few stones on the surface. Included areas make up 2 to 15 percent of the map unit.

Permeability of this soil is moderate, and runoff is medium to rapid. The available water capacity is high, generally about 11 inches within a depth of 60 inches. The organic matter content is moderate, generally about 3 percent. Natural fertility is medium. This soil is slightly acid or medium acid throughout.

Nearly all the acreage of this soil is in grass. Most areas are used for pasture.

This soil is unsuited to cultivation. Steepness is the principal limitation for the practical use of farm machinery. In addition, the soil is subject to severe erosion if cultivated.

This soil is suited to adapted species of permanent grasses. Care needs to be taken to prevent overgrazing once the grasses are established. Residue left on top of the soil catches snow, reduces runoff and evaporation, and aids in storing moisture in the soil.

This soil is suited to adapted species of trees and shrubs. Plant competition is the main limitation to the establishment of seedlings. Runoff and erosion are hazards in windbreak establishment. Planting the seedlings on the contour with intervening strips of sod helps reduce erosion. Hand hoeing, roto-tilling, or appropriate herbicides can be used in the tree rows after the seedlings have been planted.

This soil is generally not suitable for sanitary facilities because of the steep slope. A suitable alternate site should be considered. The design of dwellings and other buildings should accommodate the slope, or the site can be graded.

Steepness of slope, hign frost action, and low strength are limitations for local roads and streets. A suitable grade on the steep slopes can generally be provided by using cuts and fills or by following the contour. Damage to roads from frost action can be reduced by crowning the road and constructing side ditches to provide surface drainage. Side banks and ditches can be mulched and seeded to prevent them from eroding. The subbase and surface pavement of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade can be used to insure better performance.

This soil is assigned to capability unit VIe-1 and windbreak suitability group 3.

MhC—Marshall silty clay loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on the divides and ridgetops of loess uplands. The areas of this soil are continuous, irregularly shaped strips that are generally several hundred acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. The subsoil is friable silty clay loam about 39 inches thick. The upper part is very dark grayish brown. The middle part is dark brown and brown, and the lower part is dark yellowish brown. The underlying material, to a depth of 60 inches, is grayish brown and dark yellowish brown, mottled silty clay loam.

Permeability is moderate. Runoff is medium. The available water capacity is high, generally about 12 inches within a depth of 60 inches. Organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. The surface layer and the upper part of the subsoil are medium acid or slightly acid. This soil dries quickly after rain and is easily worked within a fairly wide range of moisture content.

Most of the acreage of this soil is farmed.

This soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases must be controlled. Erosion and runoff are the principal hazards. These can be controlled by conservation tillage and contour farming. Terraces can help protect this soil from concentrated runoff. Returning crop residue to the soil increases the intake of water and helps maintain the organic matter content. Timely tillage, or working the soil when it is not too wet, reduces compaction and helps maintain soil structure. Legumes help maintain the structure and porosity of this soil.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weeds are controlled. Erosion is a minor hazard. Cultivation between the rows with conventional equipment helps store moisture in the soil and controls weeds and grasses. In the tree rows, roto-tilling or appropriate herbicides can be used. Planting the trees and shrubs on the contour reduces erosion.

This soil is generally suited to use as septic tank absorption fields. Slope is a limitation for sewage lagoons. In most places, the slope can be modified by grading to make a site suitable for a sewage lagoon. Sewage lagoons must be lined or sealed to prevent seepage. The moderate shrink-swell potential and low strength of the subsoil are limitations for small buildings. Foundations should be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil.

This soil has limitations for local roads and streets because of its low strength and high frost action. The road subbase and surface pavement should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches help provide surface drainage.

This soil is assigned to capability unit IIe-1 and windbreak suitability group 3.

MhD2—Marshall silty clay loam, 5 to 11 percent slopes, eroded. This is a strongly sloping, well drained soil on side slopes on loess uplands. The slopes are convex away from the drainageways and concave next to the drainageways. Slopes average 8 percent. Areas of this soil are generally several hundred acres in size and are irregular in shape.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick. One-half to all of the original surface layer has been eroded, and the upper part of the subsoil has been incorporated into the surface layer. The subsoil, below the surface layer, is friable silty clay loam about 33 inches thick. The upper part is dark brown, and the lower part is brown. The underlying material, to a depth of 60 inches, is brown, mottled silty clay loam. In some areas, the subsoil is more grayish. In some places next to drains and in concave positions there has been little erosion, and the surface layer is up to 12 inches thick. In other places, erosion has been severe, and up to 10 inches of the subsoil has been removed.

Permeability is moderate. Runoff is medium or rapid, depending upon the use of the soil and the vegetative cover on the surface. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. The surface layer is medium acid or slightly acid. The subsoil is slightly acid. This soil dries quickly after rain and is easily worked within a fairly wide range of moisture content.

Most of the acreage of this soil is farmed. A small part is urban land. A few small areas are in grass.

This soil is suited to corn, wheat, soybeans, grain sorghum, oats, alfalfa, clover, and grasses. Erosion and loss of moisture and soil nutrients through runoff are the principal hazards. Conservation tillage and return of crop residue to the soil help increase the intake of water and maintain the organic matter content and soil structure. Terraces, grassed waterways, and contour farming help control runoff and erosion. Limited use of clean-cultivated row crops and maximum use of close-growing small grains effectively reduce soil erosion. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Fertilizing, on the basis of soil tests and the needs of the crop grown, is beneficial if needed. Soil compaction is reduced and soil structure is preserved by timely tillage or working the soil when it is not too wet. Legumes in the cropping sequence add nitrogen to the soil and help maintain soil structure and porosity.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, need deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs survive and grow well on this soil. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating after planting helps to reduce competition from weeds. Roto-tilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour reduces erosion. The trees and shrubs need to be protected from damage by livestock.

This soil is generally suited to use as septic tank absorption fields. Constructing the field on the contour and land shaping are generally necessary. The soil is suitable for sewage lagoons, but extensive grading is required to modify the slope and to shape the lagoon. Sewage lagoons must be lined or sealed to prevent seepage. The moderate shrink-swell potential and strong slopes are limitations for dwellings and small commercial buildings. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling of the soil. Buildings should be designed to accommodate the slope, or the site should be graded.

High frost action and low strength are limitations for roads and streets. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help to provide surface drainage.

This soil is assigned to capability unit IIIe-8 and windbreak suitability group 3.

MkE—Marshall-Ponca silt loams, 11 to 17 percent slopes. These soils are moderately steep and well drained on uneven side slopes on loess uplands. About 50 to 60 percent of the map unit is Marshall soil and about 40 to 50 percent is Ponca soil. Commonly, the Marshall soil is on concave slopes next to drains, and the Ponca soil is on convex knolls. Areas range from about 10 to 50 acres in size.

Typically, the Marshall soil has a very dark gray, friable silt loam surface layer about 10 inches thick. The subsoil is friable silty clay loam about 30 inches thick. The upper part is very dark grayish brown, the middle part is brown, and the lower part is brown and mottled. The underlying material, to a depth of 60 inches, is grayish brown, mottled silt loam. In some areas, the subsoil is more grayish than is typical.

Typically, the Ponca soil has a very dark grayish brown, friable silt loam surface layer about 10 inches thick. The subsoil is about 20 inches thick. The upper part is dark grayish brown, friable silty clay loam; the middle part is grayish brown, mottled, friable silty clay loam; and the lower part is grayish brown, mottled calcareous silt loam. The underlying material, to a depth of 60 inches, is grayish brown, mottled calcareous silt loam.

Permeability of these soils is moderate. Runoff is medium to rapid. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. These soils are high in natural fertility. Generally, the surface layer and upper part of the subsoil are medium acid or slightly acid. The Ponca soil is mildly alkaline below a depth of 28 inches. These soils dry quickly after rain and are easily worked within a fairly wide range of moisture content.

Most of the acreage of these soils is in trees or grasses and is used as wooded pasture or as habitat for wildlife. A few small areas are farmed.

These soils are poorly suited to cultivated crops. Close-growing crops, such as small grains and legumes, are most suitable. Erosion and runoff are the principal hazards. Steepness of slope limits the use of some farm machinery, and construction and maintenance of terraces and grassed waterways is difficult. If close-growing crops and legumes are grown, cultural practices such as conservation tillage and crop residue management help control erosion, reduce evaporation of soil moisture, and add organic matter. If clean-cultivated row crops are grown, terraces, contour farming, and grassed waterways also are needed to prevent erosion. The use of fertilizer and legumes helps maintain fertility.

These soils are suited to grasses. Introduced grasses, such as smooth brome, require fertilization and proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, switchgrass, and little bluestem, can be used for permanent grass. Plant residue left on the soil increases the intake of water and reduces evaporation.

Adapted species of trees and shrubs survive well and grow fairly well on these soils. Plant competition, loss of moisture through runoff, and erosion are the principal hazards. Cultivating the soil helps to reduce plant competition. Planting the seedlings on the contour with strips of sod between the rows reduces erosion. Rototilling or appropriate herbicides can be used in the tree rows after the seedlings have been planted.

These soils are poorly suited to use as building sites and for sanitary facilities because of the moderately steep slope. Constructing a septic tank absorption field on the contour is generally necessary. These soils are not generally suitable for use as sewage lagoons because of the steep slope and the risk of seepage. On sites for dwellings, the moderate shrink-swell potential and steepness of slope are limitations. Foundations need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling. The design of dwellings and other buildings should accommodate the slope, or the site can be graded.

High frost action and low strength are limitations for roads and streets. Crowning the road by land grading and constructing side ditches to provide surface drainage reduce damage to roads by frost action. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser material for subgrade or base material can be used to insure better performance. In places, cuts and fills are needed to provide a suitable grade for roads and streets. Side banks and ditches should be mulched and seeded to permanent vegetation to prevent erosion.

These soils are assigned to capability unit IVe-1 and windbreak suitability group 3.

MmC—Mayberry clay loam, 3 to 9 percent slopes. This is a gently sloping to strongly sloping, moderately well drained soil. It is on knolls and side slopes on glacial uplands. A few pebbles, cobbles, and stones are on the surface. Areas are about 5 to 30 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 6 inches thick. The subsoil is about 54 inches thick. It is dark brown, firm clay loam in the upper part; dark reddish brown and brown, mottled, very firm clay in the middle part; and grayish brown and brown, mottled, very firm silty clay and clay in the lower part. The underlying material, to a depth of 80 inches, is yellowish brown, grayish brown, and dark reddish brown, mottled, stratified silty clay, loam, and sandy loam. In places, the surface layer and upper part of the subsoil are silty clay loam.

Included with this soil in mapping are small areas of less clayey Morrill soils on side slopes. The included soils make up 2 to 25 percent of the map unit.

Permeability is slow. Runoff is medium to rapid depending on the use of the soil and the amount of vegetation and residue on the surface. The available water capacity is moderate, generally about 7 inches within a depth of 60 inches. The content of organic matter is moderate, about 3 percent. This soil is medium in natural fertility. It is slightly acid or medium acid in the surface layer and upper part of the subsoil. This soil dries slowly and stays wet during prolonged periods of rainfall. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. Workability of the soil is fairly good only during optimum moisture content. The subsoil is sticky and tough when wet and very hard when dry. It cracks when it dries.

About half of the acreage of this soil is cultivated and half is in grass. Cultivated areas are cropped mainly to grain sorghum, wheat, and soybeans. The grassed areas are used mainly as pasture.

This soil is suited to grain sorghum, wheat, corn, soybeans, oats, forage sorghum, and alfalfa. Because of the moderate available moisture capacity, this soil is best suited to cool-season small grains such as wheat or to drought resistant crops such as sorghum. In addition to drought, erosion is a major hazard. Loss of soil nutrients and loss of soil moisture through runoff are management concerns. Conservation tillage and return of crop residue to the soil help increase the intake of water, reduce evaporation of surface moisture, maintain the content of organic matter, and reduce erosion. Excessive compaction from tillage should be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Timely tillage reduces soil compaction and helps preserve soil structure. Terraces, grassed waterways, and contour farming help to control runoff and erosion.

If mechanical conservation practices are not used, this soil can be protected from severe erosion by limiting the use of clean-cultivated row crops and by making maximum use of close-growing small grains, legumes, or legume-grass mixtures. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Legumes in the cropping sequence add nitrogen to the soil, maintain soil structure, and help keep the soil porous.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and proper stocking and rotation grazing or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, generally require deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs planted on this soil have a fair chance of survival and growth. This soil absorbs and releases moisture too slowly to sustain

good tree growth. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil. Cultivating after planting helps reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting on the contour reduces erosion.

This soil is not suited to use as septic tank absorption fields because of its slow permeability. An alternate system is needed. This soil has limitations for use as sewage lagoons because of slope. The high shrink-swell potential of the subsoil is the main limitation to use of this soil as a site for dwellings and other buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. On sites for dwellings and buildings with basements, a tile drainage system installed at floor level carries away seep water if the soil becomes saturated. A suitable outlet is needed. Grading to keep surface runoff away from the buildings is generally necessary.

The high shrink-swell potential, frost action, and low strength are limitations for local roads and streets. Shrinking and swelling can be reduced by mixing additives, such as hydrated lime, with the base material. Damage from frost action can be reduced by grading and crowning the road and constructing side ditches for surface drainage. The surface pavement and subbase of road and streets should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIIe-2 and windbreak suitability group 4C.

MoC—Monona silt loam, 2 to 5 percent slopes. This is a gently sloping, well drained soil on divides and ridgetops on loess uplands. Areas are continuous, irregularly shaped strips generally 30 to 100 acres or more in size.

Typically, the surface layer is very dark grayish brown, friable silt loam about 7 inches thick. The subsoil is dark brown and brown, friable silt loam about 29 inches thick. The underlying material, to a depth of 60 inches, is brown and yellowish brown, mottled silt loam. In some areas, the slope is as much as 7 percent.

Permeability is moderate. Runoff is medium. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 percent. This soil is high in natural fertility. The surface layer and subsoil are slightly acid. This soil dries quickly after rain and is easily worked within a wide range of moisture content.

Most of the acreage of this soil is farmed and is cropped mainly to soybeans, corn, and grain sorghum. Small tracts are urban land and farmsteads.

This soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases must be controlled. Erosion and loss of moisture through runoff are the principal hazards. These can be controlled by conservation tillage and contour farming. Terraces can help protect this soil from concentrated runoff. Returning crop residue to the soil helps maintain the intake of water and the content of organic matter. Timely tillage, or working the soil at the right moisture content, reduces compaction and helps maintain soil structure. Using fertilizer and including legumes in the cropping sequence help maintain fertility. Legumes also help to maintain soil structure and porosity.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weeds are controlled. Cultivating between the rows helps store moisture in the soil and controls weeds and grasses. In the tree rows, roto-tilling or appropriate herbicides can be used. Planting the trees and shrubs on the contour reduces erosion.

This soil is generally suited to use as septic tank absorption fields. In most places, the slope can be modified and shaped by grading to make a site suitable for a sewage lagoon. Sewage lagoons must be lined or sealed to prevent seepage. The moderate shrink-swell potential of the subsoil is a limitation for dwellings and other small buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling.

Low strength and high frost action are limitations for roads and streets. The subbase and surface pavement should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches help to provide surface drainage.

This soil is assigned to capability unit IIe-1 and windbreak suitability group 3.

MoF—Monona silt loam, 17 to 30 percent slopes. This is a steep, somewhat excessively drained soil on uneven side slopes on loess uplands. Areas are dissected by upland drainageways and are generally 10 to 100 acres in size.

Typically, the surface layer is very dark gray, friable silt loam about 14 inches thick. The subsoil is dark yellowish brown and brown, friable silt loam about 28 inches thick. The underlying material, to a depth of 68 inches, is brown, mottled silt loam. In some areas, the underlying material is more grayish than is typical. In places, lime is at a depth of 15 inches. In small eroded areas, the

surface layer is lighter in color and is less than 8 inches thick, and it can be calcareous.

Permeability is moderate. Runoff is rapid. The available water capacity is high, generally about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. It is neutral in the surface layer and slightly acid in the subsoil. This soil dries readily after rain and can be worked within a fairly wide range of moisture content.

Most of the acreage of this soil has an oak-hickory tree cover with an understory of bluegrass, forbs, and woody shrubs. These areas are used as wooded pasture or as habitat for wildlife. Some areas are in grass and are used as pasture.

This soil is not suited to cultivation. Steepness of slope is the principal limitation for the practical use of farm machinery. In addition, the soil is subject to very rapid runoff and severe erosion if cultivated.

This soil is suited to adapted species of permanent grasses. Warm-season grasses that have a diffuse root system are best. Management concerns are brush management, range seeding, and controlled grazing. Deferred grazing allows the desired grasses to become established. Plant residue returned to the soil helps to increase the intake of water, reduces evaporation, and prevents erosion.

Woodland management practices for this soil include fencing from livestock, removing the less desirable tree species, and general improvement of the stand.

This soil is generally unsuited to windbreak plantings. Adapted species of trees and shrubs grow fairly well on this soil, but steepness of slope limits the use of machines for planting and cultivation. Trees and shrubs can be hand planted.

This soil is not suitable for sanitary facilities or for building sites because of the steep slope and low strength. Low strength, high frost action, and steep slope are limitations for local roads and streets. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets from frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches help to provide surface drainage. Following the contour or cutting and filling may be necessary for a suitable grade. Side banks and ditches should be mulched and seeded to prevent erosion.

This soil is assigned to capability unit VIe-1 and windbreak suitability group 10.

MpG—Monona-Shelby-Kipson complex, 30 to 70 percent slopes. These soils are on uneven, very steep bluffs and canyons on uplands. They are adjacent to deeply entrenched major drainageways. The Monona soil formed in loess. It is deep and excessively drained and is generally at higher elevations on the landscape. It makes up 20 to 60 percent of this map unit. The Shelby soil formed in glacial deposits. It is deep and excessively drained and is generally at the middle elevations on the landscape. It makes up 15 to 60 percent of this map unit. The Kipson soil formed in shaly bedrock materials. It is shallow and excessively drained and is at the lower elevations on the landscape. It makes up 5 to 40 percent of this map unit. The mapped areas are 30 to 100 acres or more in size.

Typically, the Monona soil has a very dark brown, friable silt loam surface layer about 5 inches thick. The subsoil is friable silt loam about 37 inches thick. It is very dark grayish brown in the upper part and dark yellowish brown in the middle and lower parts. The lower part is calcareous. The underlying material, to a depth of 60 inches, is yellowish brown, mottled, calcareous silt loam. In a few areas, there is lime at a depth of 10 inches. In places, the slope is less than 30 percent.

Typically, the Shelby soil has a very dark brown, friable clay loam surface layer about 10 inches thick. The subsoil is about 30 inches thick. It is very dark grayish brown, firm clay loam in the upper part; dark brown, firm clay loam in the middle part; and brown, friable clay loam in the lower part. The underlying material, to a depth of 60 inches, is dark yellowish brown, yellowish brown, and grayish brown, mottled, calcareous clay loam. In some places, the subsoil is clay or loam. In places, the subsoil and underlying material are reddish.

Typically, the Kipson soil has a very dark gray, friable, calcareous silt loam surface layer about 7 inches thick. It has a transition layer that is dark grayish brown, friable silt loam about 6 inches thick. Below that, the underlying material to a depth of 20 inches is calcareous shaly loam that is mixed yellowish brown and grayish brown. Below a depth of 20 inches the underlying material is olive gray calcareous silty shale. In places, the Kipson soil has a reddish brown transition layer. In places, the underlying material contains sandstone. In some areas, the surface layer and underlying material are loam. Also, in places, the underlying material has more clay shale than is typical.

Included in mapping, on the upper part of the landscape, are soils that have a very thin, dark brown clay loam surface layer and a reddish brown clay subsoil. Also included, on some of the lower parts of the landscape, are soils that have a very dark brown fine sandy loam surface layer and a brown or grayish brown fine sandy loam subsoil and are underlain by light brownish gray sand. Also included are dark loamy soils on bottom lands next to drainageways that are frequently flooded. The included soils make up 10 to 35 percent of the map unit.

Permeability of the Monona soil is moderate. The available water capacity is high. The organic matter content is moderate. The soil is high in natural fertility.

Permeability of the Shelby soil is moderately slow. The available water capacity is high and the organic matter content is moderate. The soil is medium in natural fertility. Permeability of the Kipson soil is moderate and the available water capacity is low. The organic matter content is moderate. Natural fertility is medium. The Kipson soil contains free lime. Runoff on these soils is generally rapid.

Most of the acreage of these soils has an oak-hickory tree cover with an understory of forbs, woody shrubs, and a few grasses. These areas are mainly habitat for wildlife.

These soils are unsuited to cultivation, windbreak plantings, sanitary facilities, building sites, and most roads and streets because of their very steep slope. In most places, conventional machines for seeding grasses and for other practices cannot be used because of the slope. Grazing must be restricted because of the severe erosion hazard. These soils are best managed if left in their natural state and used as habitat for wildlife or as parkland.

These soils are assigned to capability unit VIIe-1 and windbreak suitability group 10.

MrD—Morrill clay loam, 5 to 11 percent slopes. This is a strongly sloping, well drained soil on convex side slopes of glacial uplands. Areas are about 5 to 30 acres in size.

Typically, the surface layer is dark brown, friable clay loam about 10 inches thick (fig. 7). The subsoil is about 38 inches thick. It is brown, friable clay loam in the upper part; reddish brown, friable clay loam in the middle part; and yellowish red, friable clay loam in the lower part. The underlying material, to a depth of 60 inches, is brown, mottled and stratified sandy clay loam and sandy loam. In some places, the surface layer is silty clay loam. In places, sandy loam or silt loam is at a depth of 24 inches. In other places, clayey material is at a depth of 40 inches or more.

Included with this soil in mapping are small areas, in similar positions on the landscape, of Dickinson fine sandy loam and of the finer textured Mayberry soils. Small gravelly spots and areas of soils that have a few cobbles and stones on the surface are also included. The included soils make up 2 to 15 percent of the map unit.

Permeability is moderately slow. Runoff is medium or rapid, depending on the management of the soil and the amount of vegetative cover on the surface. The available water capacity is high, about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is medium in natural fertility. The surface layer and subsoil are medium acid. This soil dries readily after rain and is easily worked within a fairly wide range of moisture content.

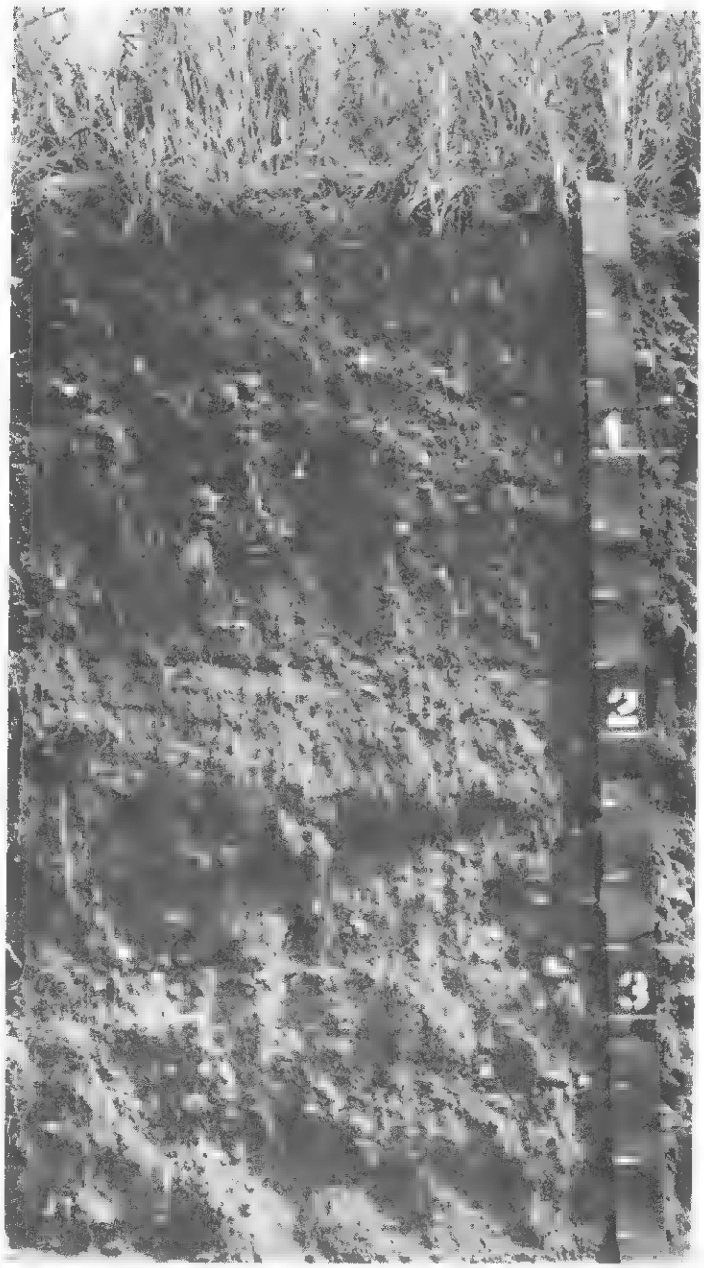


Figure 7.—Profile of Morrill clay loam, 5 to 11 percent slopes. Gravel-sized pebbles are scattered throughout the profile.

About half the acreage of this soil is cultivated, and half is in grass. Cultivated areas are cropped mainly to grain sorghum, soybeans, and wheat. Grassed areas are in both tame and native grasses and are used mainly as pasture.

This soil is suited to corn, wheat, soybeans, oats, alfalfa, and grain sorghum. Erosion and loss of moisture through runoff are the principal hazards. Conservation

tillage and the return of crop residue to the soil increase the intake of water and help maintain the content of organic matter and the soil structure. Terraces, grassed waterways, and contour farming help control runoff and erosion. Maximum use of close-growing small grains, legumes, or legume-grass mixtures is effective in reducing water erosion. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Fertilizer may be necessary. Timely tillage, or working the soil when it is not too wet, reduces soil compaction and preserves the soil structure.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and proper stocking or rotation grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, generally need deferred grazing and proper grazing use. Permanent grass effectively controls erosion if the grass is not overgrazed.

Adapted species of trees and shrubs survive well and grow well on this soil. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating after planting helps reduce plant competition. Roto-tilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour reduces erosion.

The moderately slow permeability of this soil is a limitation to its use as septic tank absorption fields, but this limitation can generally be overcome by increasing the size of the absorption field. This soil is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. Sewage lagoons must be lined or sealed to prevent seepage. The moderate shrink-swell potential of this soil is a limitation on sites for dwellings and small commercial buildings. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded. The surface pavement and subbase of roads and streets should be thick enough to compensate for the low strength of this soil. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets from frost action can be reduced by providing surface drainage. Crowning the road and constructing side ditches help drain the surface.

This soil is assigned to capability unit IIIe-1 and windbreak suitability group 3.

MsC3—Morrill-Mayberry complex, 3 to 9 percent slopes, severely eroded. This map unit consists of gently sloping to strongly sloping soils on knolls and uneven side slopes on glacial uplands. The Morrill soil is well drained, and the Mayberry soil is moderately well drained. Few to common pebbles and cobbles and a few stones are on the surface. This complex is about 45 to 85 percent Morrill soil and 15 to 55 percent Mayberry soil. Mapped areas range from about 5 to 60 acres in size.

Typically, the Morrill soil has a friable, very dark grayish brown clay loam surface layer about 7 inches thick. Nearly all of the original surface layer has been eroded, and the upper part of the subsoil has been incorporated into the surface layer. The subsoil is about 36 inches thick. The upper part is yellowish red, firm clay loam; the part below that is reddish brown, friable clay loam; and the part below that is yellowish red and brown, mottled, friable clay loam. The lower part is reddish brown, light yellowish brown, and light brownish gray, mottled clay loam. The underlying material between depths of 43 and 60 inches, is light brownish gray loam. In some areas, adjacent to drains and in concave positions, erosion has been less severe and the surface layer is thicker and darker. In some small areas on knolls, the surface layer is gravelly loam or gravelly clay loam and the subsoil has thin layers of gravelly sandy clay loam. In a few areas sandy loam, loamy sand, or sand is at a depth of 24 inches and in a few areas, compact glacial deposits of clay loam or friable grayish silt loam are below a depth of 40 inches.

Typically, the Mayberry soil has a firm, dark brown clay surface layer about 5 inches thick. Nearly all the original surface layer has been eroded, and the upper part of the subsoil has been incorporated into the surface layer. The subsoil is about 45 inches thick. The upper part is dark reddish brown and reddish brown firm clay, and the lower part is reddish brown friable clay loam. The underlying material, to a depth of 60 inches, is brown clay loam. In some concave areas that are adjacent to drains, erosion has been less severe, and the surface layer is thicker and darker than is typical; it is friable silty clay loam. In some places, the subsoil is grayish brown.

Included with these soils in mapping are small areas of Dickinson fine sandy loam on convex knolls. This soil makes up 2 to 8 percent of the map unit.

The Morrill soil has moderately slow permeability. Runoff is medium to rapid. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is moderately low or moderate, generally between 1 and 3 percent. This soil is low to medium in natural fertility. The surface layer and subsoil are medium acid or slightly acid. The Morrill soil dries rapidly after rain. Workability is good through a fairly wide range of moisture content.

Permeability of the Mayberry soil is slow. Runoff is medium to rapid. The available water capacity is moderate, generally about 8 inches within a depth of 60 inches. The organic matter content is moderately low or moderate, generally between 1 and 3 percent. This soil is low to medium in natural fertility. The surface layer is slightly acid or medium acid. The Mayberry soil dries slowly and stays wet during continued periods of rainfall. Depth to the perched water table is 1 to 3 feet in spring. Workability of the soil is fairly good only under optimal

moisture content. The soil is sticky and tough when wet and very hard when dry. It cracks when it dries.

About 75 percent of the acreage of these soils is cultivated. The rest is in grass and is used primarily as pasture.

These soils are poorly suited to all cultivated crops. Because of its moderate available water capacity, the Mayberry soil is best suited to cool-season small grains such as oats and wheat or to drought resistant crops such as grain sorghum and forage sorghum. In addition to drought, erosion is a major hazard. Other management concerns are conserving moisture and improving the organic matter content, fertility, and workability. If these soils are used for continuous row crops, erosion is difficult to control unless a combination of special conservation practices is used. Conservation tillage and return of crop residue to the soil help increase the intake of water, reduce evaporation of surface moisture, add organic matter to the soil, and prevent erosion. Excessive compaction from tillage is to be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Timely tillage helps reduce soil compaction and helps preserve soil structure. Terracing and farming on the contour help prevent erosion. Grassed waterways carry excess water from fields without causing erosion.

If mechanical conservation practices are not used, these soils can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures. The use of barnyard manure and commercial fertilizers improves the fertility of these soils.

These soils are suited to introduced grasses such as smooth brome and are suited to native grasses such as big bluestem, indiangrass, switchgrass, and little bluestem. Fertilization and proper stocking are needed on introduced-grass pastures. Proper grazing use is necessary on native rangeland.

Adapted species of trees and shrubs planted on these soils have a fair chance of survival and growth. The soils absorb and release moisture too slowly to sustain good tree growth. Plant competition and erosion are the principal hazards. Cultivating the soil before and after planting helps to reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting the trees and shrubs on the contour reduces erosion.

The moderately slow permeability of the Morrill soil and the slow permeability of the Mayberry soil limit the use of these soils as sites for septic tank absorption fields. Sewage lagoons may need to be lined and sealed to prevent seepage, especially in the Morrill soil. Grading is required to modify the slope and to shape the lagoon. On the Morrill soil, the shrink-swell potential is a moderate limitation for dwellings and other buildings; on the Mayberry soil, it is a severe limitation. Foundations must be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of these soils. If these soils are used for dwellings and buildings with basements, a tile drainage system installed at floor level helps carry away seep water if the soil becomes saturated, particularly on the Mayberry soil. Grading to keep surface runoff away from the buildings is generally necessary. The design of small commercial buildings should accommodate the slope, or the site can be graded.

The shrink-swell potential, frost action, and low strength are limitations for local roads and streets. Shrinking and swelling can be reduced by mixing additives, such as hydrated lime, with the base material. Damage by frost action can be reduced by grading and crowning the road and constructing side ditches for surface drainage. The surface pavement and subbase of roads and streets should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

These soils are assigned to capability unit IVe-8. The Morrill soil is in windbreak suitability group 3, and the Mayberry soil is in windbreak suitability group 4C.

Nc—Nodaway silt loam, 0 to 1 percent slopes. This is a nearly level, moderately well drained soil on broad stream bottom lands that is subject to occasional flooding. Areas are long, continuous strips generally 100 acres or more in size.

Typically, the surface layer is very dark gray, friable silt loam about 7 inches thick. The underlying material, to a depth of 60 inches, is alternately dark gray and very dark grayish brown, finely stratified silt loam. In some places, the fine stratification is not evident. In some areas, the original black silty clay loam is now covered with stratified silt loam sediment. This original dark soil is at a depth of 10 to 36 inches.

Included with this soil in mapping are small areas of the finer textured Zook soils in slightly lower positions on the landscape. They make up 2 to 10 percent of the map unit.

Permeability is moderate. Runoff is slow. The available water capacity is high, generally about 13 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. It is neutral throughout. A water table is at a depth of 3 to 5 feet. Except in low areas that collect water, this soil dries readily after rain and can be worked within a wide range of moisture content.

Nearly all of the acreage of this soil is cultivated. Small tracts along stream channels are in grass or trees and are habitat for wildlife.

This soil is suited to corn, grain sorghum, soybeans, oats, forage sorghum, and grasses. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects must be controlled.

Occasional flooding is the principal hazard. Diversions and dikes on the local flood plain can help protect this soil from flooding. Land grading and leveling improve surface drainage. Conservation tillage and returning crop residue to the soil increase the intake rate of water and help maintain the organic matter content.

This soil is suited to adapted species of trees and shrubs. Seedlings generally survive and grow well if moisture is conserved and weedy vegetation is removed. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment. Rototilling and herbicides can be used in the tree rows.

This soil is not suitable for use as building sites and septic tank absorption fields because of flooding. Sewage lagoons need to be diked to prevent flooding and lined and sealed to prevent seepage.

Roads should be constructed on suitable, well compacted fill material above flood level. Side ditches and culverts help protect roads from flood damage. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road and constructing side ditches help provide surface drainage. Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIw-3 and windbreak suitability group 1.

Nd—Nodaway-Colo complex, 0 to 2 percent slopes. This complex consists of nearly level, moderately well drained Nodaway soil and poorly drained Colo soil on narrow stream bottom lands that are subject to occasional flooding. Stream channels are crooked or straight and range from deep to shallow. About 40 to 60 percent of the complex is Nodaway soil and 40 to 60 percent is Colo soil. Commonly, the moderately well drained Nodaway soil is at slightly higher elevations next to stream channels. The poorly drained Colo soil is at lower elevations away from stream channels. Areas are long, narrow, continuous strips generally several hundred acres in size.

Typically, the Nodaway soil has a very dark grayish brown, friable silt loam surface layer about 7 inches thick. The underlying material, to a depth of 60 inches, is alternately dark grayish brown and very dark gray finely stratified silt loam. In some places, the surface layer is silty clay loam because of deposits that washed from the adjoining uplands. Also, in places, the original black silty clay loam is covered with stratified silt loam. This buried soil can be 18 inches below the surface.

Typically, the Colo soil has a very dark gray, friable silty clay loam surface layer about 7 inches thick. The subsurface layer is friable silty clay loam about 45 inches thick. It is very dark gray in the upper part and black in the lower part. The underlying material, between depths of 52 and 60 inches, is dark gray, mottled silty clay loam. In some areas, finely stratified silt loam sediment, 10 to 18 inches thick, has been deposited on the original surface layer. Also, in places, there are recent deposits of stratified silty clay loam.

Included in mapping are small areas of finer textured Zook soils at the lower elevations, some very poorly drained soils, and some wet spots. These included soils make up about 2 to 10 percent of the map unit. In some of the most narrow areas, waterways or stream channels make up 5 to 15 percent of the mapped area.

Permeability is moderate in the Nodaway soil and moderately slow in the Colo soil. Runoff is slow. The available water capacity is high for both soils, generally about 12 inches within a depth of 60 inches. The organic matter content is moderate, about 2 or 3 percent, for the Nodaway soil and high, about 5 percent, for the Colo soil. These soils are high in natural fertility. They are neutral or slightly acid throughout. These soils can be worked within a fairly wide range of moisture content, but they are in low areas that collect water. The water table is 1 to 3 feet deep in the Colo soil and 3 to 5 feet deep in the Nodaway soil. These soils dry slowly, especially during prolonged wet periods in spring.

About 40 percent of the acreage is cultivated, and 60 percent is in grass or trees and is used for pasture or hay. Reed canarygrass, willows, and cottonwoods are common plants, especially at the edge of stream channels and waterways.

These soils are suited to corn, grain sorghum, soybeans, and forage sorghum. Row crops, such as corn, can be grown several years in succession, but weeds, plant diseases, and insects must be controlled. Wetness due to the high water table is the main limitation, and flooding is the principal hazard. Grassed waterways, land grading or leveling to fill low areas, and tile drains to intercept ground water help overcome wetness. The flooding hazard is reduced by terraces, conservation tillage on adjoining uplands, and flood control structures. Timely tillage, or tilling the soil when it is not too wet, reduces soil compaction and helps preserve the soil structure.

These soils are suited to grasses for pasture or hay (fig. 8). Woody plants tolerant of wet conditions sometimes compete with the grasses. Introduced grasses, such as smooth brome, orchardgrass, and reed canarygrass need little fertilization because the soils are high in natural fertility. If the soils are used for pasture, proper stocking and deferred grazing are management concerns. Permanent grass produces forage and effectively controls erosion.

These soils are suited to trees and shrubs that are tolerant of occasional wetness. Establishment of seedlings is sometimes difficult during wet years. Cultivating the soil and controlling weeds are management concerns. Tilling the soil and planting seedlings after the soil has begun to dry is an effective

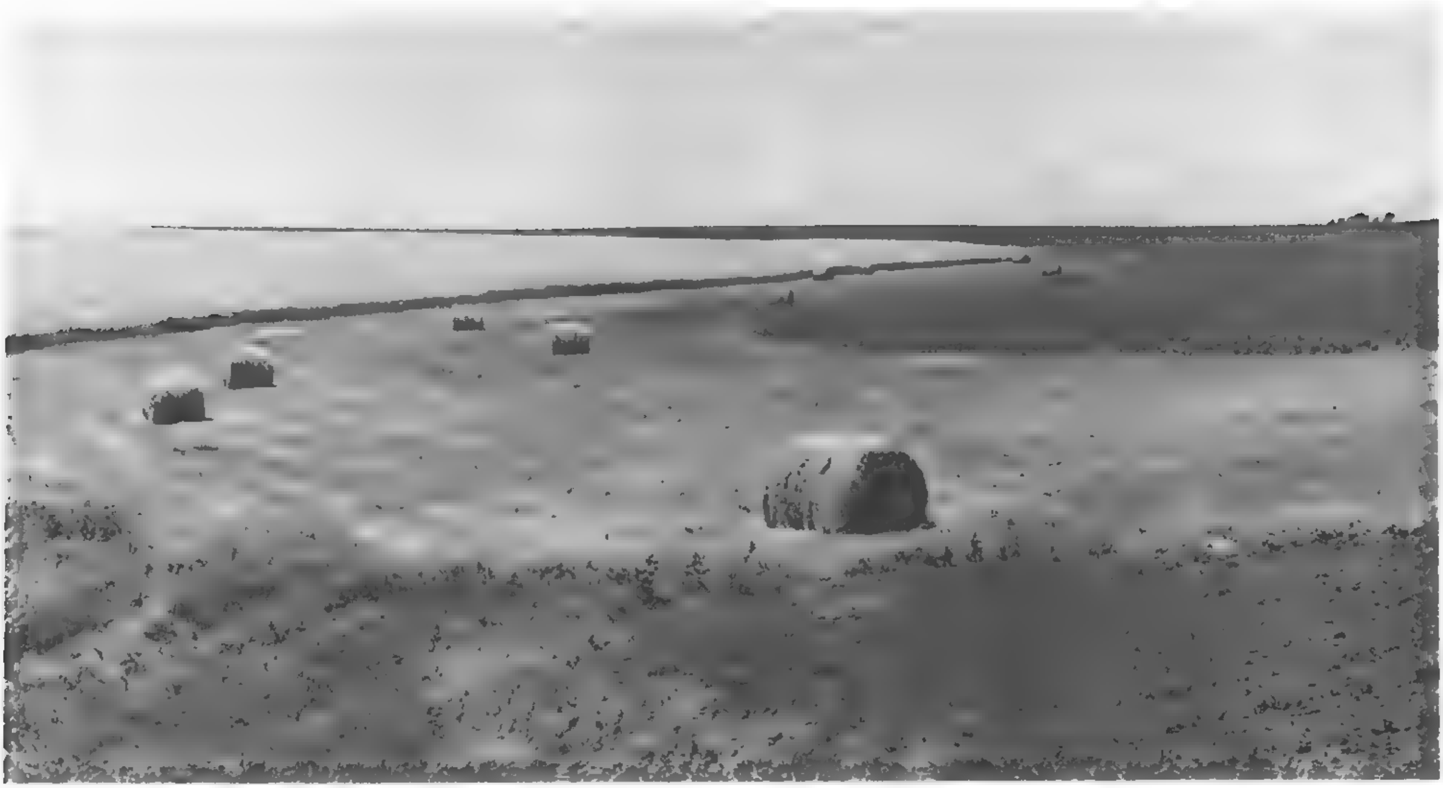


Figure 8.—Grass for hay on Nodaway-Colo complex, 0 to 2 percent slopes.

practice. Weeds can be controlled by cultivating with conventional equipment, roto-tilling, or spraying with appropriate herbicides.

These soils are not suitable for use as building sites, septic tank absorption fields, and sewage lagoons because of flooding and wetness. Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts help protect roads from flood damage. Damage to roads by frost action can be reduced by good surface drainage. Using a gravel moisture barrier in the subgrade in wet areas, crowning the road by grading, and constructing side ditches help provide surface drainage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

These soils are assigned to capability unit IIw-3. Nodaway soil is in windbreak suitability group 1, and Colo soil is in windbreak suitability group 2S.

Oc—Onawa silt loam, overwash, 0 to 1 percent slopes. This is a nearly level, somewhat poorly drained soil on broad bottom lands. The areas are subject to occasional flooding.

Typically, the surface layer is very dark grayish brown, friable, calcareous silt loam about 7 inches thick. The underlying material to a depth of about 28 inches is very firm, dark grayish brown, calcareous silty clay. From a depth of 28 inches to a depth of 60 inches it is dark grayish brown, stratified silt loam and very fine sandy loam. In some places, there is sandy material below a depth of 30 inches. In places, the loamy underlying material has 1- to 2-inch strata of silty clay.

Permeability of this soil is slow in the upper part and moderate in the lower part. Runoff is slow. The available water capacity is high, generally about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally about 2 or 3 percent. This soil is high in natural fertility. It contains free lime and is mildly alkaline in the surface layer and moderately alkaline below the surface layer. The water table is at a depth of about 3 feet in most wet years and at a depth of about 4 feet in most dry years. Workability of the surface layer is good within a fairly wide range of moisture content. This soil stays wet during prolonged periods of rain.

Most of the acreage of this soil is cultivated. This soil is suited to grain sorghum, soybeans, corn, oats, and forage sorghum. Wetness is the principal limitation. Surface drainage can be improved by using an

appropriate row direction for crops and by grading and leveling. Excessive compaction from tillage is to be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Returning crop residue to the soil improves the content of organic matter and helps maintain soil structure. The use of fertilizer helps to maintain fertility.

This soil is suited to grasses that are tolerant of somewhat wet conditions, for example, reed canarygrass, big bluestem, switchgrass, and indiangrass. Each year, 2 to 3 tons of hay per acre can be harvested using good management.

This soil is suited to trees and shrubs that are tolerant of occasional wetness. Controlling weeds is a concern in management. Cultivating between the tree rows with conventional equipment helps control weeds. Appropriate herbicides can be used in the tree rows. Areas near trees can be roto-tilled.

This soil is not suited to use as building sites or septic tank absorption fields or for sewage lagoons because of flooding, wetness, and seepage. Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts protect roads from flood damage and wetness. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Grading to crown the road and constructing side ditches help drain the surface. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIw-2 and windbreak suitability group 2S.

On—Onawa silty clay, 0 to 1 percent slopes. This is a nearly level, somewhat poorly drained soil on broad bottom lands that are subject to occasional flooding.

Typically, the surface layer is firm, very dark grayish brown, calcareous silty clay about 6 inches thick. The underlying material to a depth of about 21 inches is very firm, calcareous silty clay. It is dark grayish brown, very dark grayish brown, and very dark gray. The underlying material to a depth of 60 inches is grayish brown, stratified silt loam and very fine sandy loam. In some areas, the clayey layer above the loamy material is less than 18 inches thick. In some places, there is sandy material below a depth of 40 inches. In a few places, there is sand at a depth of 30 inches. Also, in places, the loamy underlying material has 1- to 3-inch layers of silty clay.

Permeability of this soil is slow in the upper part and moderate in the lower part. Runoff is slow. The available water capacity is high, generally about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. It has free lime and is mildly alkaline to a depth of about 24 inches and moderately alkaline below that. The high water table is at a depth of about 3 feet in wet years and at a depth of about 4 feet in dry years. This soil dries slowly and stays wet during prolonged periods of rain. The surface layer is very hard when dry.

Most of the acreage of this soil is cultivated. A few areas are in grass or trees. Most of these areas are used as wildlife habitat.

This soil is suited to grain sorghum, soybeans, corn, and forage sorghum. Wetness is the principal limitation. This soil dries slowly in spring, and adjustments in planting dates and crop varieties for planting are sometimes necessary. Surface drainage can be improved by using an appropriate row direction for crops or by grading and leveling. Excessive compaction from tillage should be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Returning crop residue to the soil improves the content of organic matter and soil structure.

This soil is suited to grasses that are tolerant of somewhat wet conditions. Suitable grasses are reed canarygrass, big bluestem, switchgrass, and indiangrass.

This soil is suited to trees and shrubs that are tolerant of occasional wetness. Establishment of seedlings is sometimes difficult during wet years. Controlling weeds is a management concern. Surface drainage can be improved by grading and leveling. After the soil has begun to dry, it can be tilled and the seedlings planted. Weeds between the rows can be controlled by cultivating with conventional equipment. Roto-tilling or appropriate herbicides can be used in the tree rows.

This soil is not suited to use as building sites or septic tank absorption fields or for sewage lagoons because of flooding, wetness, and seepage. Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts help protect roads from flood damage and wetness. Damage to roads by frost action can be reduced by providing good surface drainage and by the use of a gravel moisture barrier in the subgrade. Crowning the road by grading and constructing side ditches provide surface drainage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIw-1 and windbreak suitability group 2S.

PaC—Pawnee clay loam, 3 to 9 percent slopes. This is a gently sloping to strongly sloping soil that is moderately well drained. It is on ridgetops and side slopes on the uplands. Except for places next to drainageways, the slope is convex and averages 6 percent. Few to common pebbles and cobbles and few stones are on the surface. The areas are irregular in shape and range from about 5 to 80 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 12 inches thick. The subsoil is about 44 inches thick. It is dark brown, mottled, very firm clay in the upper part and brown, mottled, firm clay loam in the lower part (fig. 9). The underlying material to a depth of 60 inches is grayish brown, mottled, calcareous clay loam. In some areas, the surface layer is only 8 inches thick, and in some areas, the surface layer and upper part of the subsoil have less sand and are silty clay loam. Also, in places, the upper part of the subsoil is reddish brown.

In some places where this soil makes contact with the upslope Sharpsburg or Wymore soils, there are seep areas or wet spots early in spring and during wet seasons. These areas are included in mapping. Also included in mapping are small areas of the less clayey Shelby, Burchard, and Morrill soils on the steeper hillsides, dark colored Judson soils on foot slopes, and Colo soils on bottom lands next to drains. The included areas make up 2 to 15 percent of the map unit.

Permeability is slow. Runoff is medium to rapid, depending on the use of the soil and the amount of vegetation and residue on the surface. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is medium in natural fertility. The surface layer and the upper part of the subsoil are slightly acid or medium acid. This soil dries slowly and stays wet during prolonged periods of rainfall. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. Workability of the soil is fairly good only during optimum moisture content. The subsoil is sticky or very sticky when wet, very firm or tough when moist, and very hard when dry. When dry it has large cracks.

About 40 percent of the acreage of this soil is cultivated and 60 percent is in grass. Cultivated areas are cropped mainly to grain sorghum, wheat, and soybeans. The grassed areas are in native and introduced grasses and are used mainly as pasture.

This soil is suited to grain sorghum, wheat, corn, soybeans, oats, forage sorghum, and alfalfa. Because of the moderate available moisture capacity, this soil is best suited to cool-season small grains, such as wheat, or to drought resistant crops, such as sorghum. Drought and erosion are major hazards. Loss of soil nutrients and loss of soil moisture through runoff are management concerns. Conservation tillage and return of crop residue to the soil help increase the intake of water, reduce evaporation of surface moisture, maintain the content of organic matter, and reduce erosion. Excessive compaction from tillage is to be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Timely tillage minimizes soil compaction and helps preserve soil structure. Terraces, grassed waterways, and contour farming help to control runoff and erosion.

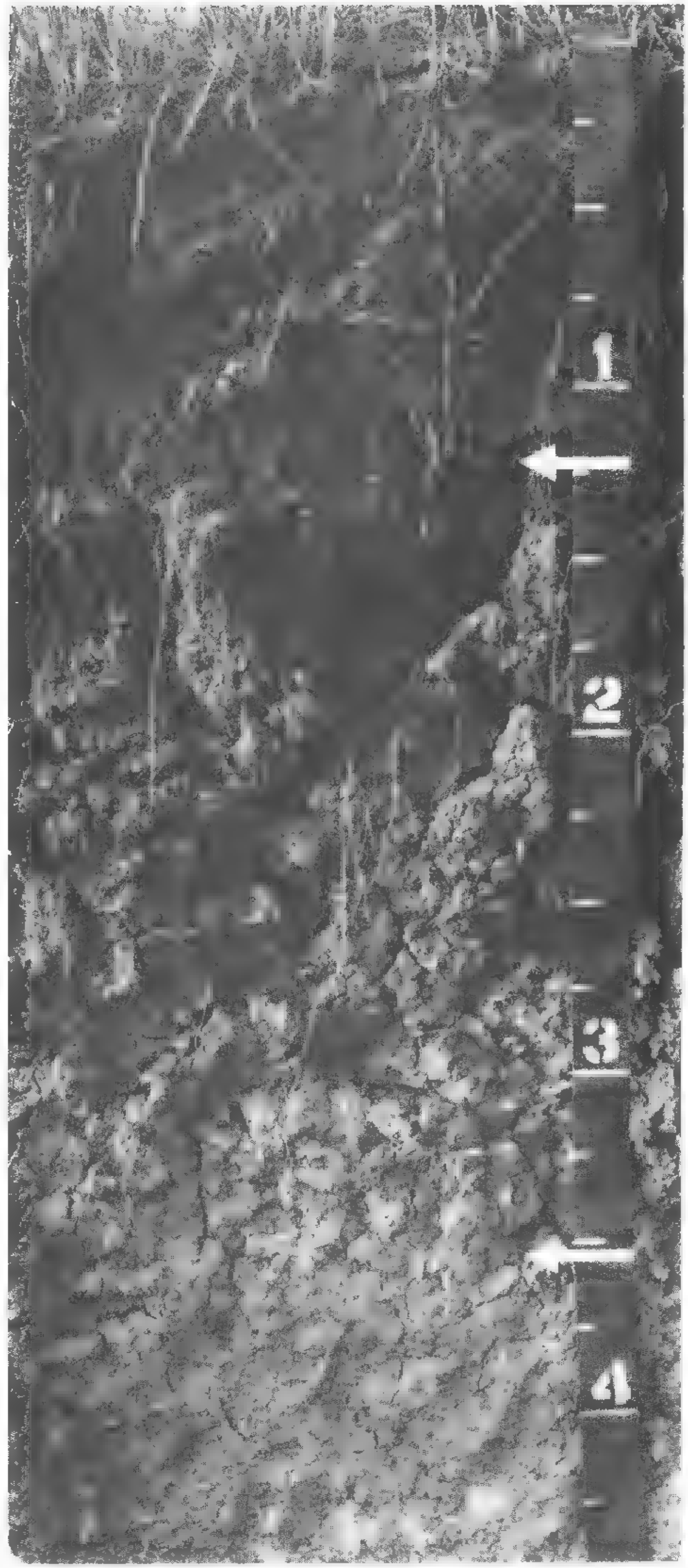


Figure 9.—Profile of Pawnee clay loam, 3 to 9 percent slopes.

If mechanical conservation practices are not used, this soil can be protected by limiting the use of clean-cultivated row crops and by making maximum use of close-growing small grains, legumes, or legume-grass mixtures. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Legumes in the cropping sequence add nitrogen to the soil, help maintain soil structure, and help keep the soil porous.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, need deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs planted on this soil have a fair chance of survival and growth. This soil absorbs and releases moisture too slowly to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil. Cultivating after planting helps to reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting on the contour reduces erosion.

This soil is not suited to use as septic tank absorption fields because of its slow permeability. A suitable alternate site or method is needed. This soil has limitations for sewage lagoons because of slope. Grading is needed to shape the lagoon. The high shrink-swell potential and wetness are limitations for most dwellings and other buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. On sites for dwellings and buildings with basements, a tile drainage system installed at floor level carries away seep water if the soil becomes saturated. A suitable outlet is needed. Grading to keep surface runoff away from the building generally is necessary. The design of small commercial buildings should accommodate the slope, or the site can be graded to an acceptable gradient.

Low strength, frost action, and shrinking and swelling are limitations for local roads and streets. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage by frost action can be reduced by grading and crowning the road and constructing side ditches for surface drainage. Shrinking and swelling can be reduced by mixing additives, such as hydrated lime, with the base material.

This soil is assigned to capability unit IIIe-2 and windbreak suitability group 4C.

PaD—Pawnee clay loam, 9 to 12 percent slopes. This is a strongly sloping soil on side slopes on glacial uplands. It is moderately well drained. Few to common pebbles and cobbles and few stones are on the surface. The areas are 5 to 35 acres in size.

Typically, the surface layer is very dark brown, friable clay loam about 12 inches thick. The subsoil is about 26 inches thick. It is dark grayish brown, mottled, very firm clay in the upper part and dark yellowish brown and grayish brown, mottled clay in the lower part. The underlying material, to a depth of 60 inches, is grayish brown, mottled, calcareous clay loam in the upper part and brown, mottled, calcareous loam in the lower part. In some areas, the upper part of the subsoil is reddish brown.

Included with this soil in mapping are small areas of the less clayey Shelby, Burchard, and Morrill soils in similar positions on the landscape. The included soils make up 2 to 10 percent of the map unit.

Permeability is slow. Runoff is medium to rapid. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is medium in natural fertility. The surface layer and the upper part of the subsoil are slightly acid or medium acid. This soil dries slowly and stays wet during prolonged periods of rain. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. Workability is fair only during optimal moisture content. The subsoil is sticky when wet, very firm when moist, and very hard when dry.

Most of the acreage of this soil is in grass. The grassed areas are in native or tame grasses and are used mainly as pasture.

This soil is poorly suited to cultivated crops. Because of the moderate available water capacity, this soil is best suited to cool-season small grains such as oats and wheat. Erosion is a major hazard. Close-growing small grains and legumes help control erosion. Conservation tillage and returning crop residue to the soil help control erosion and reduce evaporation of moisture. If clean-cultivated row crops are grown, terraces, contour farming, and grassed waterways are necessary to prevent erosion.

If intensive management is not feasible, this soil is more suitable for grasses. Introduced grasses, such as smooth brome, require fertilization and some system of rotation grazing or restricted grazing. Native grasses are the best suited as permanent grass to use for wild hay or for grazing. Plant residue left on the soil reduces runoff and evaporation of moisture.

Adapted species of trees and shrubs planted on this soil have a fair chance of survival and growth. This soil absorbs and releases moisture too slowly to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil.

Cultivating after planting helps to reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting on the contour reduces erosion.

This soil is not suited to use as septic tank absorption fields because of its slow permeability. For sewage lagoons, steepness of slope is a limitation. For small lagoons, the slope can be modified by cutting and filling, or an alternate site can be selected for this use. The high shrink-swell potential, wetness, and slope are limitations for dwellings and buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling. On sites for dwellings and buildings with basements, a tile drainage system installed at floor level carries away seep water when the soil becomes saturated. Grading to keep surface runoff away from the buildings is generally necessary. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches provide surface drainage. The base material for roads and streets can be mixed with additives, such as hydrated lime, to reduce shrinking and swelling.

This soil is assigned to capability unit IVe-2 and windbreak suitability group 4C.

PbC2—Pawnee clay, 3 to 9 percent slopes, eroded. This gently sloping to strongly sloping soil is on ridgetops and side slopes on glacial uplands. Except for areas next to upland drainageways, the slope is convex and averages about 6 percent. This soil is moderately well drained. Pebbles and cobblestones are common on the surface. The areas range from 5 to more than 150 acres in size.

Typically, the surface layer is very dark grayish brown, firm clay about 7 inches thick. One-half to all of the original surface layer has been eroded. The present surface layer mostly consists of subsoil material. The subsoil, below the surface layer, is about 38 inches thick. It is dark grayish brown and brown, mottled, very firm clay in the upper part and brown and grayish brown, mottled, firm clay loam in the lower part. The underlying material, to a depth of 60 inches, is grayish brown, mottled, calcareous clay loam. In small concave areas next to drainageways there has been little erosion, and the surface layer is thicker and darker; it is friable silty clay loam. In some of the convex areas and on hills, erosion has been severe, and the upper part of the subsoil has been removed. In some areas, the upper part of the subsoil is reddish brown.

In some places, where this soil makes contact with the Sharpsburg or Wymore soils upslope, seep areas or wet spots are present early in spring and during wet seasons. These areas are included in mapping. Also included are small areas of less clayey, eroded Shelby, Burchard, and Morrill soils, on slopes of 8 percent or more. Small areas of the thicker, dark colored Judson soils on foot slopes and small areas of Colo soils on bottom lands next to drainageways are also included. The included soils make up 2 to 15 percent of the map unit.

Permeability is slow. Runoff is medium to rapid. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderately low or moderate, generally between 1 and 3 percent. This soil is low to medium in natural fertility. The surface layer is slightly acid, and the subsoil is neutral. This soil dries slowly and stays wet during prolonged periods of rain. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. Workability of the soil is fair only under optimal moisture content. The soil is sticky when wet, firm or very firm when moist, and very hard when dry. It has large cracks when it dries.

About 60 percent of the acreage of this soil is cultivated, and 40 percent is in grass. Native and introduced grasses are grown. The grassed areas are used mainly as pasture.

This soil is poorly suited to cultivated crops. Because of the moderate available water capacity, this soil is best suited to cool-season small grains, such as oats and wheat, or to drought-resistant crops, such as grain sorghum and forage sorghum. Drought and erosion are major hazards. Management concerns are conserving moisture and maintaining the organic matter content, the fertility level, and the workability of the soil. If this soil is used for continuous row crops, erosion is difficult to control. Conservation tillage and return of crop residue to the soil help increase the intake of water, reduce evaporation of surface moisture, add organic matter, and reduce erosion. Excessive compaction from tillage is to be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Timely tillage minimizes soil compaction and helps preserve soil structure. Terracing and contour farming help control erosion. Grassed waterways carry water from fields without eroding drainageways. If mechanical conservation practices are not used, this soil can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures. The use of barnyard manure and commercial fertilizers improves the fertility of the soil.

This soil is suited to grasses for use as pasture or for hay. Pasture management includes proper stocking and

restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, require proper grazing use. Plant residue left on the soil reduces runoff and evaporation and helps store moisture in the soil. Introduced grasses, such as smooth brome, need fertilization.

Adapted species of trees and shrubs planted on this soil have a fair chance of survival and growth. The soil absorbs and releases moisture too slowly to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil. Cultivating after planting helps reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting on the contour reduces erosion.

This soil is not suited to use as septic tank absorption fields because of its slow permeability. It is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. The high shrink-swell potential and wetness are limitations on most sites for dwellings and other buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. On sites for dwellings and buildings with basements, a tile drainage system installed at floor level carries away seep water if the soil becomes saturated. Grading to keep surface runoff away from the building is generally necessary. The design of small commercial buildings should accommodate the slope, or the site can be graded.

Low strength, frost action, and shrink-swell potential are limitations for local roads and streets. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage by frost action can be reduced by grading and crowning the road and constructing side ditches for surface drainage. The base material of roads and streets can be mixed with additives, such as hydrated lime, to reduce shrinking and swelling.

This soil is assigned to capability unit IVe-4 and windbreak suitability group 4C.

PbD2—Pawnee clay, 9 to 12 percent slopes, eroded. This is a strongly sloping soil on side slopes on glacial uplands. It is moderately well drained. On most places there are pebbles and cobblestones on the surface. Areas of this soil are traversed by upland drainageways. They are irregular in shape and range from about 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, firm clay about 4 inches thick. One-half to all of the original surface layer has been eroded. The present surface layer partly consists of subsoil material. The subsoil, below the surface layer, is about 32 inches thick. The upper part of the subsoil is dark grayish brown, very firm clay; the middle part is brown, very firm, mottled clay; and the lower part is mottled, dark yellowish brown and brown, very firm, calcareous clay. The underlying material, to a depth of 60 inches, is grayish brown, mottled, calcareous clay loam and loam. In less eroded areas, the surface layer is up to 8 inches thick and is less clayey. In some areas, the upper part of the subsoil is reddish brown.

Included with this soil in mapping are small areas of the less clayey eroded Shelby, Burchard, and Morrill soils in similar positions on the landscape. Lime is exposed on the surface of the Burchard soils. The included soils make up 2 to 10 percent of the map unit.

Permeability is slow. Runoff is rapid in areas not protected by a vegetative cover. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderately low or moderate, generally between 1 and 3 percent. This soil is low to medium in natural fertility. It is slightly acid in the surface layer and neutral in the subsoil. Workability is fair only under optimal moisture content because the surface layer and subsoil are sticky when wet, very firm or tough when moist, and hard when dry. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. This soil dries slowly and stays wet during prolonged periods of rain.

Nearly all of the acreage of this soil is in grass. At one time, most areas were cultivated, but they are now seeded to both native and introduced grasses and are used for pasture. Introduced grasses are dominant.

This soil is unsuited to cultivation. Steepness of slope is the principal limitation. The soil is subject to rapid runoff and severe erosion if cultivated.

This soil is suited to adapted species of permanent grasses. Native warm-season grasses that have a diffuse root system are best suited. Effective management practices are range seeding, deferred grazing, and proper grazing use. Deferred grazing allows the grasses to become established. The return of plant residue to the soil maintains the intake of water, reduces evaporation of moisture, and prevents erosion.

Adapted species of trees and shrubs planted on this soil have a fair chance of survival and growth. This soil absorbs and releases moisture too slowly to sustain good tree growth. Drought, plant competition, and erosion are the principal hazards. Cultivating the soil before planting helps store moisture in the soil. Cultivating after planting helps reduce competition from weeds. Conventional equipment can be used to cultivate between the tree rows, and roto-tilling or appropriate herbicides can be used in the tree rows. Planting on the contour reduces erosion.

This soil is not suited to use as septic tank absorption fields because of its slow permeability. An alternate site or other disposal method is usually needed. For small

sewage lagoons, the slope can be modified by cutting and filling, or an alternate site can be selected for this use. The high shrink-swell potential, wetness, and slope are limitations for dwellings and other buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. On sites for dwellings and buildings with basements, a tile drainage system installed at floor level carries away seep water if the soil becomes saturated. A suitable outlet and proper grading to keep surface runoff away from the building are generally needed. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches help provide surface drainage. The base material of roads and streets can be mixed with additives, such as hydrated lime, to reduce shrinking and swelling.

This soil is assigned to capability unit VIe-4 and windbreak suitability group 4C.

Pf—Pits. This miscellaneous area consists of open excavations from which soil and underlying material have been removed. The slope is steep and abrupt.

The excavated material includes gravel, sand, and limestone and shale rock. The material is used in construction, in making bricks, for road surfacing, or for agricultural lime.

The available water capacity is very low. Runoff is slow in areas of gravel and rapid in areas of rock.

This miscellaneous area is not suited to crops or pasture or for sanitary facilities. It is suited to development for recreation or to use as wildlife habitat. Grading and land filling are generally required in reclaiming sites. Special grasses, shrubs, and trees need to be selected for each individual site.

This unit is assigned to capability unit VIIIs-8 and windbreak suitability group 10.

PwD2—Ponca-Dow silt loams, 5 to 11 percent slopes, eroded. These soils are strongly sloping and well drained. They are on uneven, convex side slopes on loess uplands. The areas are about 60 to 70 percent Ponca soil and about 30 to 40 percent Dow soil. The areas range from about 5 to 50 acres in size.

Typically, the Ponca soil has a friable, dark brown silt loam surface layer about 8 inches thick. One-half to all of the original surface layer has been eroded. The present surface layer consists mostly of original subsoil. The remaining subsoil is light olive brown, friable silt loam about 20 inches thick. The upper part is olive brown. The lower part is calcareous and is mottled olive gray. The underlying material, to a depth of 60 inches, is olive gray, mottled, calcareous silt loam. In some places, there is lime at a depth of more than 30 inches.

Typically, the Dow soil has a friable, grayish brown, calcareous silt loam surface layer about 6 inches thick. Most of the original surface layer has been eroded. The present surface layer consists mostly of underlying material. Some dark color remains in the surface layer because of the incorporation of organic matter. The underlying material, to a depth of 60 inches, is light brownish gray, mottled, calcareous silt loam.

Permeability of these soils is moderate, and runoff is medium to rapid. Available water capacity is high, totaling about 12 inches within a depth of 60 inches. Organic matter content is moderately low to moderate, between 1 and 3 percent, in the Ponca soil and moderately low, 1 or 2 percent, in the Dow soil. The Ponca soil is high in natural fertility. The Dow soil is medium in natural fertility. Generally, the surface layer of the Ponca soil is neutral, and that of the Dow soil is mildly alkaline. The Dow soil contains free lime. These soils dry quickly after rain and are workable within a fairly wide range of moisture content.

Nearly all of the acreage of these soils is farmed.

These soils are suited to corn, wheat, soybeans, grain sorghum, oats, alfalfa, clover, and grasses. Erosion and loss of moisture and soil nutrients through runoff are the principal hazards. Conservation tillage and return of crop residue to the soil help maintain the intake of water, the organic matter content, and the soil structure. Terraces, grassed waterways, and contour farming help control runoff and erosion. The soils can be protected by limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Fertilizer is most beneficial if application is based on soil tests and the requirements of the crop. Timely tillage reduces soil compaction and preserves soil structure.

Adapted species of trees and shrubs survive well and grow well on these soils. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating after planting helps reduce plant competition. Roto-tilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour reduces erosion. The plants need to be protected from damage by livestock.

This soil is suited to use as septic tank absorption fields. Land shaping and constructing the absorption field on the contour are generally necessary. Sewage lagoons require extensive grading to modify the slope and to shape the lagoon. Sewage lagoons must be lined or sealed to prevent seepage. The moderate shrink-swell potential of the Ponca soil is a limitation for dwellings and small commercial buildings. Foundations for

buildings need to be strengthened or backfilled with coarse material to prevent damage from shrinking and swelling. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

Low strength and frost action are limitations for local roads. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help to provide surface drainage.

These soils are assigned to capability unit IIIe-8 and windbreak suitability group 3.

PwE2—Ponca-Dow silt loams, 11 to 17 percent slopes, eroded. These soils are moderately steep and somewhat excessively drained. They are on uneven, convex side slopes on loess uplands. About 50 to 60 percent of the mapped areas is Ponca soil, and 40 to 50 percent is Dow soil. Areas range in size from about 10 to 50 acres.

Typically, the Ponca soil has a friable, dark brown silt loam surface layer about 6 inches thick. One-half to all of the original surface layer has been eroded. The present surface layer consists mostly of original subsoil material. The subsoil, below the surface layer, has been mixed by burrowing rodents and is grayish brown and brown, friable silt loam about 9 inches thick. The underlying material, to a depth of 60 inches, is light olive gray, mottled, calcareous silt loam.

Typically, the Dow soil has a grayish brown, friable, calcareous silt loam surface layer about 6 inches thick. All of the original surface layer has been eroded, and the present surface layer consists of underlying material. The underlying material, to a depth of 60 inches, is grayish brown and light brownish gray, calcareous silt loam.

Permeability of these soils is moderate, and runoff is rapid. The available water capacity is high, totaling about 12 inches within a depth of 60 inches. The organic matter content is moderately low, 1 or 2 percent, in the Ponca soil and low, 0.5 or 1 percent, in the Dow soil. The Ponca soil is medium in natural fertility, and the Dow soil is low to medium in natural fertility. Generally, the surface layer of the Ponca soil is neutral, and that of the Dow soil is mildly alkaline. The Dow soil has free lime. These soils dry quickly in spring and after rain and are easily worked within a fairly wide range of moisture content.

Most of the acreage of these soils is farmed. Some areas are in introduced grasses.

These soils are poorly suited to cultivated crops. Close-growing crops, such as small grains, legumes, and grasses, are most suitable. Erosion and runoff are the principal hazards. Steepness of slope limits the effective use of some farm machinery and makes the construction and maintenance of terraces and grassed waterways difficult. If close-growing crops and legumes are grown, cultural practices such as conservation tillage and crop residue management help to control erosion, reduce evaporation of soil moisture, and add organic matter. If clean-cultivated row crops are grown, terraces, contour farming, and grassed waterways are needed to prevent erosion.

Introduced grasses, such as bromegrass, require fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses are best suited to use as permanent grass, either for hay or pasture. Plant residue left on the soil maintains the intake of water, reduces evaporation of soil moisture, and prevents erosion.

Adapted species of trees and shrubs survive well and grow fairly well on these soils. Plant competition, loss of moisture through runoff, and erosion are the principal hazards. Cultivating the soil helps to reduce plant competition. Erosion can be reduced by planting the seedlings on the contour with strips of sod between the rows. Roto-tilling and appropriate herbicides can be used in the tree rows after the seedlings have been planted.

These soils are poorly suited to use as building sites or for sanitary facilities, mainly because of the moderately steep slope. Constructing a septic tank absorption field on the contour is generally necessary. These soils generally are not suitable for use as sewage lagoons because of the steep slope and risk of seepage. Low strength of the underlying material is a limitation for building sites on these soils. The moderate shrink-swell potential of the Ponca soil is a limitation on sites for dwellings and other buildings. Foundations for buildings can be strengthened or backfilled with coarse material to prevent damage from shrinking and swelling. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

High frost action and low strength are limitations for local roads and streets. Damage to roads by frost action can be reduced by crowning the road by grading and by constructing side ditches to provide surface drainage. The surface pavement and subbase should be thick enough to compensate for the low strength. Coarser grained material for subgrade or base material can be used to insure better performance. In places, extensive cuts and fills are needed to provide a suitable grade for roads and streets. Side banks and ditches should be mulched and seeded to prevent erosion.

These soils are assigned to capability unit IVe-8 and windbreak suitability group 3.

SaB—Sarpy-Haynie complex, 0 to 3 percent slopes. This complex consists of nearly level and very gently sloping, excessively drained Sarpy soil and moderately well drained Haynie soil. These soils are on broad stream bottom lands and are subject to occasional

flooding. This complex is 45 to 65 percent Sarpy soil and 35 to 55 percent Haynie soil. The Sarpy soil commonly is on the very gently sloping, undulating ridges. The Haynie soil is in the more nearly level areas. Areas are about 75 to 175 acres in size.

Typically, the Sarpy soil has a surface layer of dark grayish brown, calcareous loose fine sand about 6 inches thick. The underlying material, to a depth of 60 inches, is grayish brown, calcareous fine sand. In places, silt loam or very fine sandy loam is below a depth of 30 inches. In some areas, the surface layer is silty clay loam, silt loam, or very fine sandy loam and is 8 to 18 inches thick over the sand.

Typically, the Haynie soil has a very dark grayish brown, friable, calcareous very fine sandy loam surface layer about 10 inches thick. The underlying material, to a depth of 60 inches, is dark grayish brown, calcareous, stratified silt loam and very fine sandy loam. In some areas, the surface layer is fine sand, loamy fine sand, or fine sandy loam and is 8 to 18 inches thick over silt loam and very fine sandy loam.

Included with these soils in mapping are low-lying, poorly drained soils in river channels. These soils have a thin silty or clayey surface layer over sand and a water table near the surface. The included soils make up 2 to 20 percent of the complex.

The permeability of the Sarpy soil is rapid. The available water capacity is low, totaling about 4 inches within a depth of 60 inches. The organic matter content is low, generally 0.5 or 1 percent. This soil is low in natural fertility. The surface layer is mildly or moderately alkaline and contains free lime. The Sarpy soil dries rapidly and is easy to work under most conditions. It is subject to rapid leaching of nutrients, especially nitrogen.

The Haynie soil has moderate permeability. The available water capacity is high, totaling about 11 inches within a depth of 60 inches. The organic matter content is moderately low to moderate, generally between 1 and 3 percent. This soil is high in natural fertility. The surface layer is mildly or moderately alkaline and contains free lime. The Haynie soil dries readily after rain and is easy to work.

About 50 percent of the acreage of these soils is cultivated. Nonfarm areas are mainly in cottonwood trees and willows. In some places, timber is harvested. Some areas are habitat for wildlife use. Small areas are in grass.

These soils are poorly suited to cultivated crops because of their low available water capacity and the low fertility of the Sarpy soil. In addition, small low areas are wet in spring and during high channel flow. In some years, soil blowing is a minor hazard in spring. Conservation tillage and returning crop residue to the soil are recommended practices. Crop residue adds organic matter to the soil, reduces evaporation of soil moisture, and reduces soil blowing. The use of cool-season small grains or drought resistant crops helps minimize the effect of the low available moisture. Feedlot manure or fertilizer can be used to maintain or improve the fertility of these soils.

These soils are suited to grasses. Suitable introduced grasses are smooth brome, orchardgrass, and reed canarygrass. Suitable native grasses are big bluestem, indiangrass, and switchgrass.

These soils are suitable for trees and shrubs. Adapted species planted in the Sarpy soil have a fair chance of survival and growth. Lack of moisture is the main limitation. Plant competition and soil blowing are the principal hazards. If water is available, irrigation can be beneficial in dry seasons. Weeds and grasses can be controlled by cultivation. Because of the hazard of soil blowing, cultivation should generally be restricted to areas in the tree rows. Crop residue between the rows reduces soil blowing. Adapted species planted in Haynie soil have a good chance of survival and growth. Plant competition can be controlled by cultivating between the rows with conventional equipment. Roto-tilling or appropriate herbicides can be used in the tree rows.

These soils are not suitable for use as building sites, septic tank absorption fields, or sewage lagoons because of flooding and seepage.

Constructing roads on suitable, well compacted fill material above flood level and providing side ditches and culverts help protect roads from flood damage. The Haynie soil has limitations for local roads and streets because of frost action and low strength. Frost action can be reduced by crowning the road by grading and constructing side ditches to provide surface drainage. The surface pavement and subbase should be thick enough to compensate for the low strength of this soil. Coarser grained material for subgrade or base material can be used to insure better performance.

These soils are assigned to capability unit IVs-5. The Sarpy soil is in windbreak group 7, and the Haynie soil is in windbreak group 1.

Sh—Sharpsburg silty clay loam, 0 to 2 percent slopes. This is a nearly level, moderately well drained soil on the high divides of loess uplands. The areas of this soil are circular or oblong and range from 10 to more than 100 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 7 inches thick (fig. 10). The subsoil is friable to firm silty clay loam about 43 inches thick. The upper part of the subsoil is dark brown. The middle and lower parts are brown. The underlying material, to a depth of 60 inches, is dark yellowish brown and grayish brown, mottled silty clay loam.

Small circular depressions where water collects for short periods are included in mapping. These areas make up less than 5 percent of the map unit.

Permeability is moderately slow, and surface runoff is generally slow. The available water capacity is high,

Figure 10.—Profile of Sharpsburg silty clay loam, 0 to 2 percent slopes. The surface layer is 7 inches thick. The subsoil to a depth of about 24 inches has fine blocky structure. Below 24 inches the lighter colored subsoil has medium blocky structure.

totaling about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. It is medium acid or slightly acid throughout. This soil dries readily after rain and is easily worked within a fairly wide range of moisture content.

Nearly all of the acreage of this soil is farmed.

This soil is suited to corn, grain sorghum, soybeans, wheat, alfalfa, clover, and grasses. If appropriate management practices are used, this soil can be cultivated intensively without risk of damage. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases must be controlled. Maintaining the proper plant population, on the basis of the amount of soil moisture, is an effective management practice. Plant residue returned to the soil increases the intake rate of water and helps maintain the organic matter content. Soil compaction is reduced and soil structure is preserved by timely tillage or by working the soil when it is not too wet.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weedy vegetation is controlled or removed. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment. In the tree rows, roto-tilling and appropriate herbicides can be used.

The moderately slow permeability of this soil is a limitation to its use as septic tank absorption fields. This limitation can be overcome by increasing the size of the absorption field. Seepage is a hazard in sewage lagoons, but it can be overcome by lining the lagoon with less permeable material. The moderate shrink-swell potential is a limitation for dwellings and other buildings. Foundations need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling. Damage to roads and streets by frost action can be reduced by surface drainage. Crowning the road by grading and constructing side ditches are effective in draining the surface. Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit I-1 and windbreak suitability group 3.

ShC—Sharpsburg silty clay loam, 2 to 5 percent slopes. This is a gently sloping, moderately well drained soil on the high ridgetops on loess uplands. The areas are irregular strips about 10 to 100 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 12 inches thick. The subsoil is friable to firm silty clay loam about 44 inches thick. The upper part is very dark grayish brown, the middle part is brown and dark yellowish brown, and the lower part is dark yellowish brown and grayish brown. The underlying

material, to a depth of 60 inches, is grayish brown and dark yellowish brown, mottled silty clay loam.

Permeability is moderately slow, and runoff is medium. The available water capacity is high, totaling about 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. The surface layer is medium acid or slightly acid. This soil dries readily after rain and is easily worked within a fairly wide range of moisture content.

Nearly all of the acreage of this soil is farmed.

This soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases must be controlled. Erosion and loss of moisture through runoff are the principal hazards. These hazards can be reduced by conservation tillage and contour farming. Returning crop residue to the soil helps increase the intake of water and helps maintain the content of organic matter. Timely tillage reduces compaction and helps maintain soil structure. Terraces can be used to protect this soil from concentrated runoff.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weeds are controlled. Erosion is a minor hazard. To store moisture in the soil and control weeds and grasses, cultivate between the rows with conventional equipment. Within the tree rows, roto-tilling or appropriate herbicides can be used. Planting the trees and shrubs on the contour reduces erosion.

The moderately slow permeability limits the use of this soil for septic tank absorption fields. This limitation can be overcome by increasing the size of the field. This soil is suitable for sewage lagoons in most places, but grading is required to modify the slope and shape the lagoon. Seepage may hinder the function of sewage lagoons, and lagoons should be lined with less permeable material. The only limitation for dwellings and other buildings is the moderate shrink-swell potential. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling.

Damage to roads and streets by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help to provide surface drainage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIe-1 and windbreak suitability group 3.

ShC2—Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded. This is a gently sloping, moderately well drained soil on the narrow, convex ridgetops on loess uplands. The areas are irregular strips about 10 to 30 acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 7 inches thick. Half of the original surface layer or, in places, all of it has been eroded. The subsoil is about 38 inches thick. The upper and middle parts are brown, firm silty clay loam. The lower part is brown, friable, mottled silty clay loam. The underlying material, to a depth of 60 inches, is grayish brown and strong brown, mottled silty clay loam. In some areas, the surface layer is silty clay.

Permeability is moderately slow, and runoff is medium. The available water capacity is high, totaling 11 or 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. The surface layer is medium acid or slightly acid. This soil dries quickly after rain, and it is easily worked within a fairly wide range of moisture content.

Nearly all of the acreage of this soil is farmed.

This soil is suited to corn, soybeans, grain sorghum, wheat, oats, alfalfa, clover, and grasses. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, insects, and plant diseases should be controlled. Erosion and loss of moisture through runoff are the principal hazards. These hazards can be reduced by conservation tillage, contour farming, and terracing. Returning crop residue to the soil helps increase the intake of water and helps maintain the content of organic matter. Timely tillage reduces compaction and helps maintain soil structure. The use of fertilizer and legumes helps maintain fertility. Legumes also help maintain the soil structure and porosity of the soil.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weedy vegetation controlled. Erosion is a hazard. Cultivating between the rows helps store moisture in the soil and controls weeds and grasses. In the tree rows, roto-tilling or appropriate herbicides can be used. Planting the trees and shrubs on the contour reduces erosion.

The moderately slow permeability of this soil is a limitation to its use as septic tank absorption fields. This can be overcome by increasing the size of the absorption field. In most places, the slope can be graded to make the sites suitable for sewage lagoons. Seepage may hinder the function of sewage lagoons unless the lagoons are lined with a less permeable material. The moderate shrink-swell potential is a limitation for dwellings and other buildings. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil.

Damage to roads and streets by frost action can be reduced by crowning the road by grading and constructing side ditches for surface drainage. The

surface pavement and subbase of roads and streets should be thick enough to compensate for the low strength of this soil. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIe-8 and windbreak suitability group 3.

ShD2—Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded. This is a strongly sloping, moderately well drained soil on the side slopes on loess uplands. Areas are continuous, irregularly shaped strips traversed by drainageways. Except in areas adjacent to drainageways, the slope is convex and averages 7 percent. Areas are generally several hundred acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay loam about 7 inches thick. Half of the original surface layer, or all of it in some places, has been eroded. The present surface layer is mostly part of the original subsoil. Some dark color remains in the surface layer from the incorporation of organic matter. The subsoil is brown, friable silty clay loam about 33 inches thick. The lower part of the subsoil is mottled. The underlying material, to a depth of 64 inches, is grayish brown and dark yellowish brown, mottled silty clay loam. In some places the surface layer and the upper part of the subsoil are more clayey. In some areas the subsoil is more grayish, and in a few places the slope is more than 11 percent. In some places there has been little erosion, and the surface layer is up to 10 inches thick and is slightly darker in color.

In some places, where this soil makes contact with the downslope clayey Pawnee or Mayberry soils, there are wet spots early in spring and during wet seasons. These areas are included in mapping. They make up less than 5 percent of the map unit.

Permeability is moderately slow. Runoff is medium or rapid. The available water capacity is high, totaling 11 or 12 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is high in natural fertility. The surface layer is slightly acid. This soil dries rapidly after rain, and it is fairly easy to work.

Most of the acreage of this soil is farmed. Some small areas are in tame grasses, and a few small areas near farmsteads are in woodlots or windbreaks.

This soil is suited to corn, wheat, soybeans, grain sorghum, oats, alfalfa, and clover. Erosion and loss of moisture and soil nutrients through runoff are the principal hazards. Conservation tillage and the return of crop residue to the soil help increase the intake of water and help maintain the content of organic matter and the soil structure. Terraces, grassed waterways, and contour farming help control runoff and erosion. Limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures are effective in reducing water erosion. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Fertilizer is most beneficial if application is based on soil tests and the requirements of the crop. Soil compaction is reduced and soil structure is preserved by timely tillage, that is, working the soil when it is not too wet. Legumes in the cropping sequence add nitrogen to the soil, help maintain soil structure, and help keep the soil porous.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, need deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs survive and grow well on this soil. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating the soil after planting helps reduce competition from weeds. Roto-tilling or appropriate herbicides can be used in tree rows. Planting the seedlings on the contour reduces erosion.

The moderately slow permeability of this soil is a limitation for septic tank absorption fields. This limitation can be overcome by increasing the size of the absorption field. This soil is suitable for sewage lagoons, but extensive grading is required to modify the slope and to shape the lagoon. Sewage lagoons must be lined or sealed to prevent seepage. For dwellings and other buildings, foundations need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded.

Damage to roads and streets by frost action can be reduced by draining the surface. Crowning the road by grading and constructing side ditches help to provide surface drainage. Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIIe-8 and windbreak suitability group 3.

SkF—Shelby clay loam, 15 to 30 percent slopes. This is a steep and somewhat excessively drained soil on uneven side slopes of glacial uplands. Many areas are adjacent to deeply entrenched major drainageways. Pebbles and stones are common on the surface, and there are boulders here and there. Areas range from about 5 to 120 acres in size.

Typically, the surface layer is black, friable clay loam about 12 inches thick. The subsoil is about 28 inches

thick. The upper part is very dark grayish brown, firm clay loam; the middle part is brown, mottled, firm clay loam; and the lower part is grayish brown, mottled, friable clay loam. The underlying material, to a depth of 60 inches, is mottled light brownish gray and dark yellowish brown, calcareous clay loam. In some places, the surface layer is silt loam or silty clay loam, and in some places, the subsoil is reddish brown and the underlying material is noncalcareous. In other places, lime is within 20 inches of the surface.

Included with this soil in mapping are Pawnee soils in the less sloping areas, Dickinson fine sandy loam on side slopes, and calcareous Steinauer soils in the steeper areas. Pawnee soils have a clayey subsoil. Also included are escarpments along creek channels and deeply entrenched narrow bottom lands. Inclusions make up about 10 to 35 percent of each mapped area.

Permeability of this soil is moderately slow. Runoff is medium to rapid, depending on the amount of vegetation on the surface. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally between 2 and 4 percent. This soil is medium in natural fertility. The surface layer is slightly acid or medium acid.

This soil is unsuited to cultivation. Steepness and unevenness of slope are limitations, and erosion is a severe hazard in cultivated areas.

Nearly all the acreage of this soil is in grass or trees. The areas are mainly pastureland or habitat for wildlife.

This soil is suited to adapted species of permanent grass. Native grasses are most suited. Effective management practices are deferred grazing, proper grazing use, and brush control. Permanent grass effectively produces forage and controls erosion if the grass is not overgrazed. Residue left on the surface reduces runoff and evaporation and helps store moisture in the soil.

Woodland management practices include fencing the area from livestock, removing undesirable trees, and stand improvement. Small areas of this soil can be left undisturbed as habitat for wildlife.

This soil is generally unsuited to windbreak plantings. Adapted species of trees and shrubs have a fair chance of survival and growth, but steepness of slope restricts the use of machinery. Some areas, however, have smooth enough slopes for the use of machinery. Seedlings can be planted, on the contour, in a shallow furrow 18 to 24 inches wide in these smooth areas. Seedlings must be planted by hand in areas where machinery cannot be used.

This soil is not suitable for sanitary facilities or as a site for most buildings because of the steep slope. Low soil strength and the steep slope are limitations for local roads and streets. The subbase and surface pavement should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. A suitable grade for roads and streets can be obtained by cutting and filling or by following the contour.

This soil is assigned to capability unit VIe-1 and windbreak suitability group 10.

SrE—Shelby and Burchard clay loams, 9 to 15 percent slopes. These are moderately steep, well drained soils on glacial uplands. In many areas these soils have common cobbles up to 10 inches in size and a few large boulders on the surface. Areas range from about 5 to 80 acres in size. Some areas consist mainly of the Shelby soil, other areas consist mainly of the Burchard soil, and many areas consist of both soils. Commonly, the Shelby soil is on concave slopes next to drains, and the Burchard soil is on rounded convex slopes.

Typically, the Shelby soil has a black, friable clay loam surface layer about 10 inches thick. The subsoil is about 32 inches thick. The upper part is very dark grayish brown, friable clay loam; the middle part is brown, firm clay loam; and the lower part is dark yellowish brown, firm clay loam. The underlying material, to a depth of 60 inches, is grayish brown and brown mottled clay loam. In places, the subsoil is more grayish, and lime or calcareous clay loam is at a depth of 30 inches. In some places, the surface layer is up to 18 inches thick, and the dark colored upper part of the soil is 24 or more inches thick.

Typically, the Burchard soil has a very dark brown, friable clay loam surface layer about 8 inches thick (fig. 11). The subsoil is about 22 inches thick and has lime in the middle and lower parts. The upper part is very dark grayish brown, friable clay loam; the middle part is brown, calcareous, firm clay loam; and the lower part is grayish brown, firm, mottled, calcareous clay loam. The underlying material, to a depth of 60 inches, is mottled grayish brown and yellowish brown, calcareous clay loam. In a few areas that are cultivated, most of the surface layer has eroded, and the present surface layer is lighter in color and contains lime concretions or soft bodies of lime normally present in the subsoil.

Included in mapping is a well drained soil that is loam throughout. This soil makes up 0 to 20 percent of each mapped area. Also included are small areas of Dickinson fine sandy loam on knolls, calcareous Steinauer soils on steeper slopes, Pawnee soils, which have a clayey subsoil, in less sloping areas, and a soil on knolls that has gravel, cobbles, and stones on the surface. The included soils make up 2 to 15 percent of each mapped area.

Permeability of the Shelby and Burchard soils is moderately slow, and runoff is medium to rapid. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally between 2 and 4 percent. These soils are medium in natural fertility. Their surface layer is

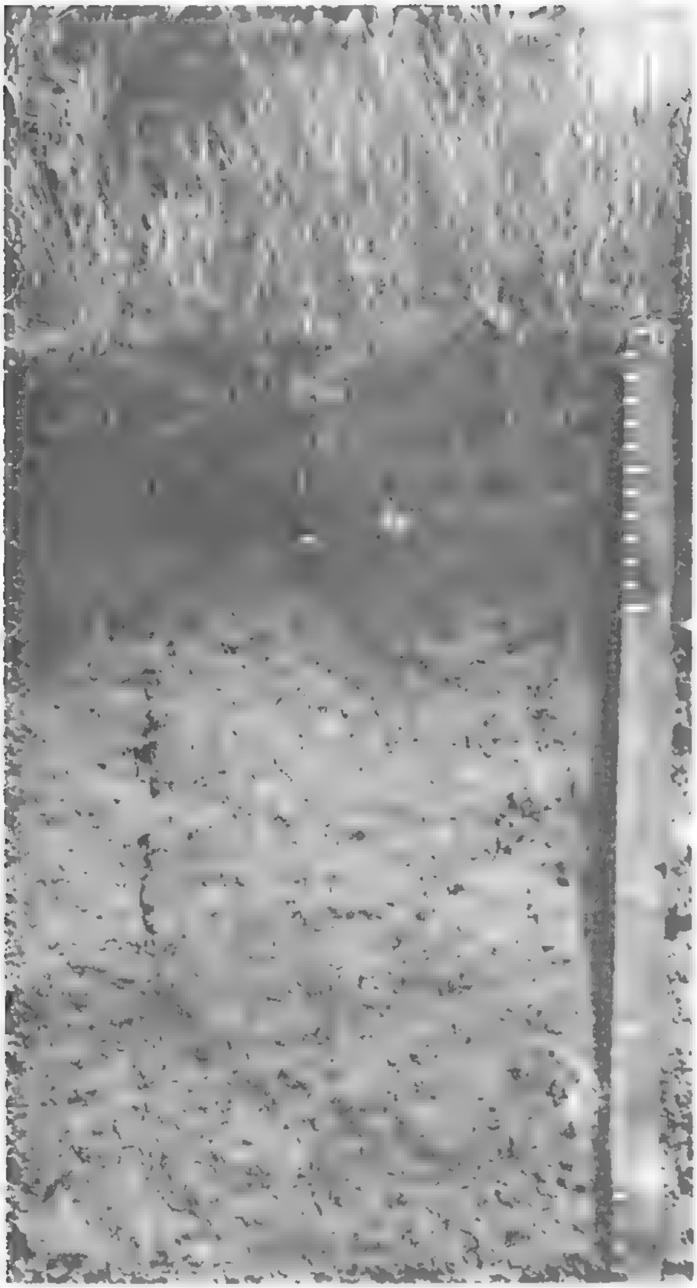


Figure 11.—Profile of Burchard clay loam, 9 to 15 percent slopes. This soil formed under grasses in clay loam glacial material.

generally slightly acid or medium acid. The Burchard soil is alkaline below a depth of 30 inches. These soils dry readily after rain and can be worked within a fairly wide range of moisture content.

About 75 percent of the acreage of these soils is in grass, and about 25 percent is farmed. Areas of native or introduced grasses are used for pasture. Native grasses in some small areas are cut for wild hay. Cultivated areas are cropped mainly to grain sorghum, wheat, and alfalfa.

These soils are poorly suited to cultivated crops. If used for cultivated crops, a cropping system that consists mainly of close-growing crops such as small grains and legumes is best. Erosion is the principal hazard. Steepness of slope limits the effective use of some farm machinery and makes construction and maintenance of terraces and grassed waterways difficult. If close-growing crops are grown, cultural practices such as conservation tillage and residue management help control erosion, reduce evaporation of soil moisture, and add organic matter. If clean-cultivated row crops are grown, terraces, contour farming, and grassed waterways are needed to help prevent erosion. Intensive management is necessary in crop production, otherwise the soils should be put to other uses.

These soils are suited to grasses. Introduced grasses, such as smooth brome, need fertilization. If the soils are used for pasture, proper stocking is a management concern. Native grasses such as big and little bluestem, indiangrass, and switchgrass are the best to use as permanent grass for wild hay or for grazing. Residue left on the surface reduces runoff and evaporation and aids in storing moisture in the soil.

Adapted species of trees and shrubs survive well and grow fairly well on these soils. Plant competition, loss of moisture through runoff, and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating after planting helps to reduce plant competition. Planting the seedlings on the contour and the use of terraces reduce erosion.

The moderately slow permeability of these soils is a limitation to their use as septic tank absorption fields. To overcome this, the size of the absorption field can be increased. Generally, the absorption fields should be constructed on the contour for proper operation. Steepness of slope is a limitation for sewage lagoons. An alternative site or method should be selected. The shrink-swell potential and steepness of slope are limitations on sites for dwellings and other buildings. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling. The design of dwellings and small commercial buildings should accommodate the slope, or the site can be graded. The surface pavement and subbase of roads and streets should be thick enough to compensate for the low strength of these soils. Coarser grained material for subgrade or base material can be used to insure better performance.

These soils are assigned to capability unit IVe-1 and windbreak suitability group 3.

StF—Steinauer clay loam, 11 to 20 percent slopes. This is a somewhat excessively drained, moderately

steep soil on uneven, convex slopes on glacial uplands. There are gravel size pebbles and an occasional boulder on the surface, and stones are common. Areas are 5 to 40 acres in size.

Typically, the surface layer is very dark grayish brown, friable, calcareous clay loam about 5 inches thick (fig. 12). A transition layer, between the surface layer and the underlying material, is friable, calcareous clay loam about 13 inches thick. It is dark grayish brown in the upper part and yellowish brown in the lower part. The underlying material, to a depth of 60 inches, is firm, grayish brown, mottled, calcareous clay loam. In a few areas adjacent to drainageways, the surface layer is thicker, and lime is below the surface layer or at a depth of more than 13 inches.

Permeability of this soil is moderately slow, and runoff is rapid. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is low or moderately low, generally between 0.5 and 2 percent. This soil is low to medium in natural fertility. It contains free lime. Workability is good within a medium range of moisture content.

Nearly all areas of this soil are in grass. A few small areas are in trees or are cultivated. The areas of grass are either in native or introduced grasses and are used mainly for pasture. Some small areas of native grasses are cut for wild hay.

This soil is generally unsuited to cultivated crops. Steepness of slope is its principal limitation, and susceptibility to erosion is its principal hazard.

This soil is suited to adapted species of permanent grasses that are tolerant of a high content of lime. The roots of sod-forming varieties, such as big bluestem, switchgrass, little bluestem, and sideoats grama, help bind the surface soil and prevent erosion. Proper grazing use is a management concern. Residue on the surface of the soil reduces runoff and evaporation and aids in storing moisture in the soil.

Trees and shrubs planted in this soil have a fair chance of survival but grow poorly. Species that can tolerate the high lime content of this soil are most suitable. Erosion and lack of available moisture are the principal hazards. Cultivating the soil before and after planting helps to overcome plant competition. Planting the seedlings in strips and on the contour with intervening areas of sod helps reduce erosion. Conifers can be planted in a wide, shallow furrow.

This soil generally is not suitable for sanitary facilities because of the moderately steep slope. Steepness of slope is a limitation for dwellings and other buildings. The design of these buildings should accommodate the slope, or the site can be graded. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil.

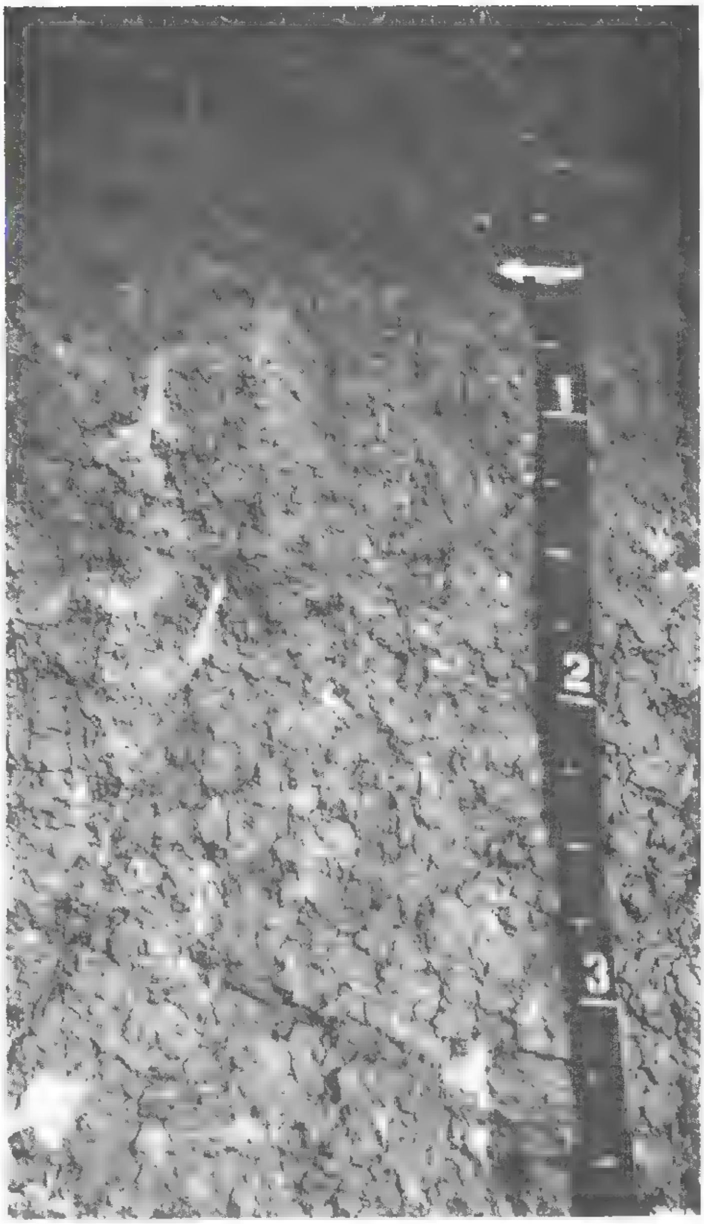


Figure 12.—Profile of Steinauer clay loam, 11 to 20 percent slopes. The surface layer is about 5 inches thick. This soil has seams and pockets of lime in the underlying glacial material

Cuts and fills are generally needed to get a suitable grade for roads and streets. The subbase and surface pavement of roads should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit VIe-9 and windbreak suitability group 8.

Wa—Wabash silty clay, 0 to 1 percent slopes. This is a nearly level, very poorly drained soil on broad bottom lands. It is subject to occasional flooding.

Typically, the surface layer is black, very firm silty clay about 10 inches thick. The subsurface layer is about 35 inches thick. It is black, very firm silty clay. The subsoil is about 11 inches thick. It is very dark gray, very firm silty clay. The underlying material, to a depth of 60 inches, is dark grayish brown, mottled silty clay.

Included with this soil in mapping are small areas of saline and alkaline Zoe soils. They make up less than 10 percent of the map unit.

Permeability and runoff are very slow. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. The surface layer is slightly acid or medium acid. This soil dries slowly. During heavy rainfall, the upper 12 inches of the soil is saturated with water. The soil is difficult to work because it is sticky and tough when wet, and it cracks and becomes very hard when dry. It can only be worked within a narrow range of moisture content.

Most of the acreage of this soil is farmed. The main crops are grain sorghum and soybeans.

This soil is suited to cultivated crops. Wetness is the principal limitation. Soybeans, corn, and sorghum can be grown. Grain sorghum or soybeans may be preferable to corn because they can be planted later in spring. Hot dry periods in the summer can adversely affect corn. The soil holds moisture tightly and does not release it quickly enough to maintain corn plants.

Forage sorghum and grasses can also be grown for use as livestock feed. Reed canarygrass, prairie cordgrass, and tall fescue are tolerant of wet conditions.

Surface drainage can be improved by using an appropriate row direction for crops or by land grading and leveling. Filling low areas so that there is an even land grade throughout the field helps drain the surface of the soil. In places, surface ditching may be feasible. Excessive compaction from tillage should be avoided when the soil is wet. Compaction further reduces the permeability of the soil. Returning crop residue to the soil improves the organic matter content and soil structure.

This soil is suited to trees and shrubs that are tolerant of wetness. Establishment of seedlings is difficult during wet years. Cultivating the soil and controlling weeds are management concerns. Weeds can be controlled by cultivating the soil with conventional equipment before and after planting and by applying selected herbicides. In some years, cultivating and planting may be postponed because the soil is too wet.

This soil is not suited to use as septic tank absorption fields because of flooding, wetness, and very slow permeability. It is suited to sewage lagoons if the area is diked or protected from flooding. This soil is not suitable for use as building sites because of flooding, wetness, and the shrink-swell potential.

Roads should be constructed on suitable, well compacted fill material. Side ditches and culverts help protect roads from flood damage and wetness. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance.

This soil is assigned to capability unit IIIw-1 and windbreak suitability group 2W.

Wt—Wymore silty clay loam, 0 to 2 percent slopes. This is a nearly level, moderately well drained soil mainly on the divides of loess uplands. In a few areas it is on foot slopes or in bench positions. The areas of this soil are circular or oblong and range from 10 to more than 200 acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 10 inches thick. The subsoil is about 42 inches thick. It is very dark grayish brown and dark grayish brown, firm silty clay in the upper part; olive brown, mottled, firm silty clay in the middle part; and grayish brown, mottled, friable silty clay loam in the lower part. The underlying material, to a depth of 60 inches, is grayish brown, mottled silty clay loam.

Small circular depressions where water collects for short periods are included in mapping. The soil in these areas is poorly drained. These included areas make up less than 5 percent of the map unit.

Permeability and surface runoff are slow. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally 3 or 4 percent. This soil is high in natural fertility. The surface layer is medium acid or slightly acid. This soil dries slowly in spring and during prolonged periods of rainfall. A saturated water zone or perched water table is at a depth of 1 to 3 feet in spring. Workability of the soil is fairly good only during optimal moisture content. This soil releases moisture slowly to plants, and upon drying it develops cracks and becomes hard.

Nearly all of the acreage is farmed.

This soil is suited to grain sorghum, corn, wheat, soybeans, oats, alfalfa, clover, and grasses. Hot, dry periods in the summer can adversely affect cultivated crops. Otherwise, this soil can be cultivated intensively, without risk of damage, by using appropriate farming practices. Maintaining the proper plant population, on the basis of the amount of soil moisture, is an effective management practice. Plant residue returned to the soil increases the intake rate of water and helps maintain the organic matter content. Soil compaction is reduced and soil structure preserved by timely tillage, that is, working the soil in spring when it is not too wet. Legumes in the cropping system help maintain the fertility and porosity of this soil.

This soil is suited to trees and shrubs. Seedlings of adapted species generally survive and grow well if moisture is conserved and weedy vegetation controlled or removed. Weeds and grasses can be controlled by cultivating between the rows with conventional equipment. In the tree rows, roto-tilling and appropriate herbicides can be used.

The slowly permeable subsoil and seasonal wetness severely limit the use of the soil as septic tank absorption fields. An alternate system should be considered. This soil is generally suited to sewage lagoons. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from the shrinking and swelling of the soil. At sites for dwellings and buildings with basements, a tile drainage system at the floor level conveys seep water to a suitable outlet if the soil becomes saturated.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by surface drainage. Crowning the road by grading and constructing side ditches are effective in draining the surface.

This soil is assigned to capability unit IIs-2 and windbreak suitability group 4L.

WtC2—Wymore silty clay, 2 to 7 percent slopes, eroded. This is a gently sloping, moderately well drained soil on high ridges of the loess uplands. The areas are commonly dissected by drainageways. In places, the ridges are separated by lower lying, saddlelike areas. The ridges between the drainageways are convex, and the saddles and low-lying areas adjacent to drainageways are plane to concave. The slope averages about 4 percent. Areas are generally broad and are several hundred acres in size.

Typically, the surface layer is very dark grayish brown, firm silty clay about 6 inches thick. Nearly all of the original surface layer has been eroded. The present surface layer mostly consists of clayey subsoil material. The subsoil is about 30 inches thick. It is mottled, dark grayish brown, dark yellowish brown, and grayish brown, firm silty clay in the upper part and mottled, grayish brown and dark yellowish brown, friable silty clay loam in the lower part. The underlying material, to a depth of about 60 inches, is mottled, grayish brown and dark yellowish brown silty clay loam. In small, less eroded areas the surface layer is silty clay loam and is more than 10 inches thick. In other areas, as much as one-half or more of the clayey subsoil has been eroded. In places, there are lime concretions or hard nodules of lime in the lower part of the subsoil. In some areas, the subsoil is less clayey and is more grayish. In some places, the lower part of the subsoil and the underlying material consist of glacial deposits.

In some places where this soil makes contact with the clayey Pawnee or Mayberry soils, there are poorly drained areas or wet spots early in spring. These areas are included in mapping. Also included are small areas of the dark colored Judson, Colo, and Nodaway soils on foot slopes or bottom lands. The included areas make up 2 to 10 percent of the map unit.

Permeability is slow. Runoff is medium to rapid. The available water capacity is high, totaling about 10 inches within a depth of 60 inches. The organic matter content is moderate, generally 2 or 3 percent. This soil is medium in natural fertility. The surface layer is slightly acid or medium acid. This soil dries slowly in spring. A saturated water zone or a perched water table is at a depth of 1 to 3 feet in spring. Workability is fair only under optimal moisture content. This soil is sticky when wet, firm or very firm when moist, and very hard when dry. It has large cracks when it dries. This soil releases moisture slowly to plants.

Most of the acreage is farmed. Small areas are in introduced grasses, windbreaks, and farmsteads.

This soil is suited to grain sorghum, wheat, corn, soybeans, oats, alfalfa, and clover. Erosion and loss of moisture and soil nutrients through runoff are the principal concerns in management. Hot, dry periods in the summer can adversely affect cultivated crops. Conservation tillage and return of crop residue to the soil help increase the intake of water, reduce evaporation of moisture, and help maintain the content of organic matter. Terraces, grassed waterways, and contour farming help to control erosion. Limited use of clean-cultivated row crops and maximum use of close-growing small grains, legumes, or legume-grass mixtures are effective in reducing erosion. Row crops can be grown more frequently if terraces, waterways, and contour farming are used. Excessive compaction from tillage is to be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Fertilizer and the use of legumes in the cropping sequence help to maintain fertility. Legumes also keep the soil porous.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization and some system of proper stocking, rotation grazing, or restricted grazing. Native grasses, such as big bluestem, indiangrass, switchgrass, and little bluestem, need deferred grazing and proper grazing use. Permanent grasses produce forage and effectively control erosion if they are not overgrazed.

Adapted species of trees and shrubs survive and grow well on this soil. Plant competition and erosion are the principal hazards. Cultivating the soil before planting helps to store moisture in the soil. Cultivating after planting helps to reduce competition from weeds. Roto-tilling or appropriate herbicides can be used in the tree rows. Planting the seedlings on the contour reduces erosion. The plants need to be protected from damage by livestock.

This soil is not suited to use as a septic tank absorption field because of its seasonal wetness and the slow permeability of the subsoil. An alternate system or site should be considered. The soil is suitable for sewage lagoons, but grading is required to modify the slope and to shape the lagoon. Foundations for buildings need to be strengthened and backfilled with coarse material to prevent damage from shrinking and swelling of this soil. If the soil is used for dwellings and buildings with basements, a tile drainage system at floor level helps carry away seep water if the soil becomes saturated. A suitable outlet is needed.

Roads and streets should have a surface pavement and subbase thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads and streets by frost action can be reduced by good surface drainage. Crowning the road by grading and constructing side ditches help to provide surface drainage.

This soil is assigned to capability unit IIIe-2 and windbreak suitability group 4L.

Zh—Zoe silty clay loam, 0 to 1 percent slopes. This is a nearly level, poorly drained saline soil on broad bottom lands. It is subject to occasional flooding.

Typically, the surface layer is very dark gray, firm silty clay loam about 8 inches thick. The subsurface layer is about 28 inches thick. The upper part is black silty clay loam, the middle part is very dark gray silty clay loam that contains light colored threads of salt accumulations, and the lower part is very dark grayish brown silty clay. The underlying material, to a depth of 60 inches, is dark grayish brown mottled silty clay. In some places, the subsurface layer is very thin, and the underlying material is at a depth of about 20 inches. Also, in places, the underlying material is grayish brown or brown silty clay loam.

Included with this soil in mapping are areas, in similar positions on the landscape, of the Zook and Wabash soils, which do not have salts in the subsoil. Included soils make up 15 to 30 percent of the map unit.

Permeability and runoff are very slow. The available water capacity is moderate, totaling about 8 inches within a depth of 60 inches. The organic matter content is moderately low or moderate, generally between 1 and 3 percent. This soil is low to medium in natural fertility. It has a poor soil-moisture-plant relationship because of the content of sodium salts. This soil is difficult to work because it stays wet during rainy periods and becomes very hard during dry periods. The depth to a perched water table is 1 to 3 feet.

Most of the acreage of this soil is cultivated. A few small areas are in grass and are used for pasture or hay.

This soil is poorly suited to cultivated crops. It has restrictive physical properties because of the sodium salts. Salts close the soil pores and restrict permeability. The soil stays wet during rainy periods. When it dries, it becomes very hard and droughty. Cool-season small grains, such as wheat and barley, and drought-resistant crops, such as grain sorghum, can be grown. Forage sorghum and grasses can also be grown for use as livestock feed. Surface drainage of this soil can be improved by using an appropriate row direction for crops, filling in low areas, and having an even land grade throughout the field. In places, surface ditching may be feasible. Excessive compaction from tillage should be avoided, particularly when the soil is wet. Compaction reduces the permeability of the soil. Any kind of organic material, such as crop residue, barnyard manure, and corn cobs, when added to the soil, helps water to enter the soil, helps hold water in the soil, reduces evaporation of moisture, and improves the ease of tillage.

This soil is poorly suited to grasses, but a mixture of suitable grasses can be used. Suitable grasses include the fescues, wheatgrass, reed canarygrass, Canada wildrye, indiangrass, and switchgrass.

This soil is poorly suited to windbreaks because it has sodium salts and restrictive physical properties. Establishment of seedlings is sometimes difficult in wet years. Lack of moisture in dry years and plant competition are also limitations. Species tolerant of saline or alkaline soil conditions are most suited. During wet years, planting may have to be delayed until the soil has begun to dry. Weeds can be controlled by cultivation between the rows with conventional equipment. Areas in the row and close to trees can be hand hoed or roto-tilled.

This soil is not suited to use as septic tank absorption fields because of flooding, wetness, and slow permeability. This soil is suited to sewage lagoons if the lagoon is raised or diked to protect it from flooding. This soil is not suitable for use as building sites because of flooding, wetness, and the high shrink-swell potential.

Constructing roads on suitable, well compacted fill material and building side ditches and culverts help protect roads from flood damage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage to roads from frost action can be reduced by providing surface drainage. A gravel moisture barrier can be used in the subgrade. Crowning the road and constructing side ditches help to drain the surface.

This soil is assigned to capability unit IVs-2 and windbreak suitability group 9S.

Zo—Zook silty clay loam, 0 to 1 percent slopes. This is a nearly level, poorly drained soil on broad bottom lands. It is subject to occasional flooding. Areas range from about 20 to several hundred acres in size.

Typically, the surface layer is very dark brown, friable silty clay loam about 10 inches thick. The subsurface

layer is about 34 inches thick. It is black, friable silty clay loam in the upper part and black, firm silty clay in the lower part. The subsoil is about 22 inches thick. It is firm, dark gray silty clay. The underlying material, to a depth of 80 inches, is dark gray silty clay.

Included with this soil in mapping are small areas of the saline-alkaline Zoe soils. The included areas make up 2 to 10 percent of the map unit.

Permeability and runoff are slow. The available water capacity is high, totaling about 9 inches within a depth of 60 inches. The organic matter content is high, about 5 percent. This soil is high in natural fertility. The surface layer is neutral to medium acid. This soil dries slowly and stays wet during winter and early in spring and during periods of continuous rainfall. A saturated water zone or a perched water table is at a depth of 1 to 3 feet.

Nearly all of the acreage of this soil is cultivated. A few areas are used for pasture or for hay.

This soil is suited to corn, soybeans, and grain sorghum. Row crops, such as corn and soybeans, can be grown several years in succession, but weeds, plant diseases, and insects must be controlled. Wetness is the principal limitation of this soil, especially during long periods of rainfall. Surface drainage can be improved by grading and filling and by planting row crops in a direction conducive to drainage. Excessive compaction from tillage is a hazard, particularly when the soil is wet. Compaction reduces the permeability of the soil. Crop residue returned to the soil helps maintain the content of organic matter and the soil structure.

This soil is suited to grasses. Introduced grasses, such as smooth brome, need fertilization. If this soil is used for pasture, proper stocking or some system of controlled grazing is necessary.

This soil is suited to species of trees and shrubs that are tolerant of occasional wetness. Seedlings are sometimes difficult to establish during wet years. Cultivation of the soil and weed control are management concerns. Weeds can be controlled by cultivation with conventional equipment before and after planting and by application of selected herbicides. During wet years, cultivation may be delayed until the soil has begun to dry.

This soil is not suited to use as septic tank absorption fields because of flooding, wetness, and slow permeability. This soil is suited to sewage lagoons if the lagoon is raised or diked to protect it from flooding. This soil is not suitable for use as building sites because of flooding, wetness, and a high shrink-swell potential.

Roads should be constructed on suitable, well compacted fill material above flood level. Side ditches and culverts help protect roads from flood damage. The surface pavement and subbase should be thick enough to compensate for the low strength of the soil material. Coarser grained material for subgrade or base material can be used to insure better performance. Damage from frost action can be reduced by draining the surface. A gravel moisture barrier can be used in the subgrade. Crowning the road and constructing side ditches help to provide surface drainage.

This soil is assigned to capability unit IIw-4 and windbreak suitability group 2W.

prime farmland

In this section, prime farmland is defined and discussed, and the prime farmland soils in Otoe County are listed.

Prime farmland is one of several kinds of important farmland defined by the U.S. Department of Agriculture. It is of major importance in providing the nation's short- and long-range needs for food and fiber. The acreage of high-quality farmland is limited, and the U.S. Department of Agriculture recognizes that government at local, state, and federal levels, as well as individuals, must encourage and facilitate the wise use of our nation's prime farmland.

Prime farmland soils, as defined by the U.S. Department of Agriculture, are soils that are best suited to producing food, feed, forage, fiber, and oilseed crops. Such soils have soil properties that are favorable for the economic production of sustained high yields of crops. The soils need only to be treated and managed using acceptable farming methods. The moisture supply, of course, must be adequate, and the growing season has to be sufficiently long. Prime farmland soils produce the highest yields with minimal inputs of energy and economic resources, and farming these soils results in the least damage to the environment.

Prime farmland soils may presently be used as cropland, pasture, or woodland, or they may be in other uses. They are either used for producing food or fiber or are available for these uses. Urban and built-up land or water areas cannot be considered prime farmland.

Prime farmland soils usually get an adequate and dependable supply of moisture from precipitation or irrigation. The temperature and growing season are favorable. The acidity or alkalinity level of the soils is acceptable. The soils have few or no rocks and are permeable to water and air. They are not excessively erodible or saturated with water for long periods and are not frequently flooded during the growing season. The slope ranges mainly from 0 to 6 percent.

Some soils that have a high water table qualify as prime farmland, but only in areas where this limitation has been overcome by drainage. Onsite evaluation is necessary to determine the effectiveness of corrective measures. More information on the criteria for prime farmland soils can be obtained at the local office of the Soil Conservation Service.

prime farmland in Otoe County

About 237,866 acres, or nearly 60 percent of the county, is prime farmland. A recent trend in land use in some parts of the county has resulted in the loss of some prime farmland to urban and industrial uses. The loss of prime farmland to other uses puts pressure on marginal lands, which generally are wet, more erodible, droughty, or difficult to cultivate and less productive than prime farmland.

The following map units, or soils, make up prime farmland in Otoe County. The location of each map unit is shown on the detailed soil maps at the back of this publication. The extent of each unit is given in table 4. The soil qualities that affect use and management are described in the section "Detailed soil map units." This list does not constitute a recommendation for a particular land use.

Co Colo silty clay loam, 0 to 1 percent slopes (where drained)
Ha Haynie silt loam, 0 to 2 percent slopes
Ju Judson silt loam, 0 to 2 percent slopes
JuC Judson silt loam, 2 to 6 percent slopes
Ke Kennebec silt loam, 0 to 1 percent slopes
KnB Kennebec-Nodaway silt loams, 0 to 4 percent slopes
MhC Marshall silty clay loam, 2 to 5 percent slopes
MoC Monona silt loam, 2 to 5 percent slopes
Nc Nodaway silt loam, 0 to 1 percent slopes
Nd Nodaway-Colo complex, 0 to 2 percent slopes (where drained)
Oc Onawa silt loam, overwash, 0 to 1 percent slopes (where drained)
On Onawa silty clay, 0 to 1 percent slopes (where drained)
Sh Sharpsburg silty clay loam, 0 to 2 percent slopes
ShC Sharpsburg silty clay loam, 2 to 5 percent slopes
ShC2 Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded
Wt Wymore silty clay loam, 0 to 2 percent slopes
WtC2 Wymore silty clay, 2 to 7 percent slopes, eroded
Zo Zook silty clay loam, 0 to 1 percent slopes (where drained)

use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as rangeland and woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

crops and pasture

William E. Reinsch, conservation agronomist, and Howard E. Sautter, soil scientist, Soil Conservation Service, prepared this section.

Most of the agricultural land in Otoe County is used for cultivated crops. According to the Nebraska Agriculture Statistics, about 70 percent of the acreage in the county is planted to crops. The largest acreage is in corn and sorghum, followed by wheat and soybeans. Other crops are alfalfa, hay, and oats. About 3 percent of the cropland is irrigated. About 20 percent of the acreage in the county is used for pasture.

General management needed for crops and pasture is suggested in this section. The crops or pasture plants best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Detailed soil map units." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

cropland management

Most of the soils in Otoe County are suitable for crop production. On a large acreage on the uplands, however, erosion is a severe hazard, and the soils need to be protected by conservation practices. Other soils, generally on the bottom lands, are poorly drained, and some system of drainage is needed.

Good management practices on cropland are those that control runoff and erosion, conserve moisture, maintain soil tilth, and maintain or improve drainage. Terraces, contour farming, grassed waterways, and tillage that leaves crop residue on the surface help to reduce water erosion. Leaving crop residue on the surface or growing a protective plant cover helps reduce sealing and crusting of the surface during and after heavy rain. In winter, standing stubble catches drifting snow, which provides additional moisture. The overall hazard of erosion can be reduced if the less erodible and more productive soils are used for row crops and the more erodible soils are used for close-grown crops, such as small grain and alfalfa, or for hay and pasture.

The sequence of crops grown on a field, in combination with the practices needed for the management and conservation of the soil, is known as a cropping system. The cropping system should preserve soil tilth and fertility, maintain a plant cover that protects the soil from erosion, and control weeds, insects, and diseases. Cropping systems vary according to the soils on which they are used. For example, Pawnee clay loam, 9 to 12 percent slopes, requires a high percentage of

grasses and legumes in the cropping sequence to control erosion and maintain soil tilth. In contrast, on Kennebec silt loam, 0 to 1 percent slopes, a higher percentage of row crops can be grown in the cropping sequence.

Soils must be worked to prepare a seedbed, to control weeds, and to provide a favorable place for plants to grow. Excessive tillage, however, breaks down the granular structure in the surface layer that is needed for good soil tilth. Therefore, tillage operations are limited to those that are essential. Various methods of conservation tillage are used in Otoe County. The conservation tillage systems of till-plant, disk, or chisel and plant are well suited to row crops. Grasses can be established by drilling into stubble without further seedbed preparation.

fertilizer

Soils used for cultivated crops need to be tested to determine their need for additional nutrients. The kind and amount of nutrients to be applied is based on results of soil tests. The kind of crop to be grown, the availability of moisture, and the previous cropping history are considered in fertilizer recommendations. Certain crops, such as corn, are heavy users of nitrogen, and other crops, such as alfalfa, are heavy users of phosphorus.

For nonlegume crops, nitrogen fertilizer is beneficial on all soils in the county but especially on eroded soils. Nitrogen stimulates plant growth. Somewhat less nitrogen is needed when the subsoil is dry. Generally, less nitrogen is needed for a grain or forage crop that immediately follows a legume in the cropping sequence because legumes fix nitrogen in the soil, and that nitrogen is available to the succeeding crop.

Phosphate fertilizer does not leach through the soil profile and must be incorporated or worked into the soil. Phosphate fertilizer is beneficial on all upland soils, particularly the eroded soils. The content of phosphorus generally is higher in the bottom land soils than in upland soils, but all soils need to be checked for phosphorous deficiencies. Legumes, especially, benefit from the use of phosphate fertilizer.

Calcium or lime is an important component of the soil. It is not only used by plants for growth, but it affects soil reaction. Soil reaction determines, to a great extent, availability of elements such as phosphorus, nitrogen, and minor nutrients. Some soils in the county, such as Albaton, Dow, Haynie, Onawa, Sarpy, and Steinauer soils, are alkaline and contain free lime. This alkalinity sometimes hinders the availability of phosphorus and minor elements. All other soils in the county generally have a slight to strong degree of acidity and would benefit from the use of lime. Soils should be tested to determine the amount of lime needed. Liming an acid soil helps to make other elements available for plant growth.

Zinc is the minor element most likely to be deficient in eroded soils and in soils that have been scalped after construction of terraces.

Potassium content is generally very high for all the soils in Otoe County.

herbicides

Use of herbicides is an excellent way to control weeds. Care should be taken to apply the correct type of herbicide at the proper rate to correspond with soil conditions. The colloidal clay and humus fraction of the soil is responsible for the greatest chemical activity in the soil. Crop damage from herbicides can occur on sandy sites (sites low in colloidal clay) and in areas where the organic matter content is moderately low to low. Consequently, application rates of herbicides need to be correspondingly lowered on these soils. Keeping field boundaries on the contour helps to maintain the organic matter content of the soils, thereby lessening the danger of damage from herbicides.

Irrigation

In Otoe County, 10,740 acres were irrigated in 1978. Irrigation is used mainly to supplement natural rainfall during critical stages of plant growth. These critical stages occur in July or early in August during pollination of corn or sorghum and during early seed development of plants. In an average year, 4 to 8 inches of additional water is put on the fields by gravity or sprinkler irrigation systems. Most of the water comes from rivers, streams, and reservoirs. Only a few deep wells are used for irrigation.

On soils such as Wymore or Sharpsburg that have slopes of 2 to 7 percent, the sprinkler system is the most practical. The conservation practices that help control erosion on nonirrigated cropland also apply to irrigated land. These include terraces, contour farming, grassed waterways, and conservation tillage that leaves a protective cover of residue on the soil. The terraces and grassed waterways must be maintained. The hazard of erosion is reduced if conservation practices are used. During dry periods in July and August, the soil has formed small cracks and is receptive to water, and crop plants have reached their peak growth and form a vegetative canopy over the soil. This canopy protects the soil from the forceful impact of water drops, either from the sprinkler system or heavy rainstorms. Sprinkler irrigation is least efficient on hot and windy days during July and August because water is lost through evaporation and the wind causes uneven distribution. Efficiency is improved by watering during the evenings or on cool, calm days.

For a soil such as Wymore silty clay, 2 to 7 percent slopes, eroded, permeability and water intake are slow. Under clean cultivation and during early stages of crop growth in spring, it would be difficult to apply water at a rate slow enough for the soil to absorb it all. If a

sprinkler system is used, the surface layer would fill with water and slow the downward movement of water. The soil would be subject to severe erosion during heavy rainstorms. Land treatment practices to prevent erosion are especially important if sprinkler irrigation is used in spring on clean-cultivated fields.

Sprinkler irrigation can have special use in conservation. It can be used on sloping soils to establish new crops, new grasses for pasture, or for watering windbreaks. Some of the poorly drained clayey soils and the excessively drained sandy soils in the Missouri River Valley are sometimes irrigated to supplement natural rainfall.

On nearly level soils, a gravity or furrow irrigation system is suited to row crops. In Otoe County, the principal nearly level soils are Colo silty clay loam, 0 to 1 percent slopes, Judson silt loam, 0 to 2 percent slopes, Kennebec silt loam, 0 to 1 percent slopes, Nodaway silt loam, 0 to 1 percent slopes, Sharpsburg silty clay loam, 0 to 2 percent slopes, Wymore silty clay loam, 0 to 2 percent slopes, and Zook silty clay loam, 0 to 1 percent slopes. Land leveling is necessary for proper drainage, and it increases the efficiency of irrigation because water is distributed evenly through the field. In the flatter fields, the length of the rows or run and the amount of water applied is determined mainly by the intake rate or permeability of the soils.

Soils suited to irrigation generally have a high available moisture capacity and hold about 2 inches of available moisture for each foot of soil. A crop that utilizes moisture to a depth of 3 feet will have about 6 inches of available moisture. Maximum efficiency in use of water by plants is obtained if irrigation is started when about one half of the stored water has been used by the plants. Thus, if a soil holds 6 inches of available water, irrigation can be started when about 3 inches have been used by the crop.

All of the soils in Nebraska can be placed in an irrigation design group. These design groups are described in the Nebraska Irrigation Guide (*8*), which is part of the technical specifications for conservation in Nebraska. Assistance in planning and designing for irrigation is available through the Soil Conservation Service or the Extension Service.

pasture

In Otoe County, pastures of introduced grasses consist mainly of cool-season grasses, which start to grow early in spring and reach peak growth in May or June. These grasses are dormant during July and August and start to grow again in the fall. For this reason, it is desirable to have warm-season pastures or ranges consisting of native grasses or temporary pastures of sudangrass that attain peak growth during July and August. This combination provides green plants during the entire growing season.

Introduced grasses are best utilized if grown in rotation with cultivated crops. Introduced grasses yield more forage than native grasses but require fertilization and weed control. They are more costly to maintain. Best results are obtained by reestablishing stands when they begin to deteriorate. Protecting the soils during reseeding helps prevent severe damage from runoff and erosion.

Introduced grasses are used for cool-season grass pasture. Smooth brome is the species most commonly grown in this county, but orchardgrass, tall fescue, and reed canarygrass are also grown. On the upland soils and well drained bottom land soils, legumes, such as alfalfa or birdsfoot trefoil, are more suitable.

The management of introduced pasture is geared to grazing in spring and fall, after the grasses reach a height of 5 or 6 inches. Until the plants reach this height, they grow on food reserves stored in their roots and rhizomes. Grazing too early in spring or too late in fall weakens the plants.

Introduced grasses respond to fertilizers, but soil tests and estimates of the amount of available soil moisture should be used as guides to determine the amount and kind of fertilizer to apply. Grasses are likely to need nitrogen. If a legume is included, phosphate fertilizer generally is needed.

yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 5. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 5 are grown in the survey area, but estimated yields are not listed because the acreage of such crops is small. The local

office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for rangeland, for woodland, and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, woodland, wildlife habitat, or recreation.

Capability units are soil groups within a subclass. The soils in a capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIe-1 or IIIe-2.

The acreage of soils in each capability class and subclass is shown in table 6. The capability classification of each map unit is given in the section "Detailed soil map units."

The best management practices for soils in class I are timely tillage; control of weeds, plant diseases, and harmful insects; proper levels of soil nutrients and proper plant populations; and effective use of crop residue. To prevent erosion on soils in class IIe and class IIIe, additional recommended practices are: leaving crop residue on the soil through the winter, contour farming, grassed waterways, and a conservation tillage system that leaves at least 1,500 pounds per acre of corn or sorghum residue or 750 pounds per acres of small grain residue on the surface when planting a succeeding crop. Furthermore, terraces are recommended on soils in class IIIe (fig. 13). For soils in class IVe, grasses and legumes in the cropping system, terraces, contour farming, and grass waterways are good management practices. If row crops are planted, a conservation tillage system that leaves at least 2,000 pounds per acre of corn or sorghum residue or 1,000 pounds per acre of small grain residue on the surface helps reduce erosion to an acceptable level.

Some nearly level soils in classes IIw, IIIw, or IVs are somewhat poorly drained or poorly drained because of their clayey texture and slow permeability or because of a high water table. Good farming practices and a system of improved drainage are beneficial on those soils. Water ponds on the surface if the clayey or slowly permeable soils are saturated. Surface drainage can be improved by an appropriate row direction for crops and by land grading and leveling. Filling in low areas and maintaining an even land grade throughout the field help water drain from the surface. In places, open drainage ditches can be used. On soils that have a high water table, underground tile systems can be used to lower the water table if suitable outlets can be located. If drainage cannot be improved, crops or grasses that are tolerant of wet conditions can be planted.

Figure 13.—Grain sorghum and wheat on capability class IIIe soils. Terracing, contour farming, and grassed waterways are recommended for these soils.

rangeland

Peter N. Jensen, range conservationist, Soil Conservation Service, prepared this section.

In areas that have similar climate and topography, differences in the kind and amount of vegetation produced on rangeland are closely related to the kind of soil. Effective management is based on the relationship between the soils and vegetation and water.

Only a small acreage in Otoe County is rangeland. Rangeland, for the most part, is confined to the steep slopes and to areas where the soils are not suitable for cultivation.

Different kinds of range produce different kinds and amounts of native grasses. Range can be managed properly if the kind of range site is known as well as the kinds of plants that are suitable for that site. Management then can be directed to the most suitable plants.

Proper grazing is the most important range management practice. A practice that improves the condition of the range is range seeding. Rangeland that has an undesirable plant population can be seeded in order to establish desirable native grasses.

In Otoe County, the following soils are especially suited to perennial grasses. Dickinson fine sandy loam, 11 to 20 percent slopes; Kipson-Benfield complex, 6 to 20 percent slopes; Marshall-Ponca silt loams, 11 to 17 percent slopes; Monona silt loam, 17 to 30 percent slopes; Pawnee clay, 9 to 12 percent slopes, eroded; Ponca-Dow silt loams, 11 to 17 percent slopes, eroded; Shelby and Burchard clay loams, 9 to 15 percent slopes; Shelby clay loam, 15 to 30 percent slopes; and Steinauer clay loam, 11 to 20 percent slopes. These soils can be seeded to native warm-season grasses, such as big bluestem, little bluestem, indiangrass, switchgrass, and sideoats grama. No care other than management of grazing is needed to maintain forage composition.

Assistance in managing warm season native grasses or rangeland can be obtained from the local office of the Soil Conservation Service.

woodland

Keith A. Ticknor, forester, Soil Conservation Service, prepared this section.

About 2.8 percent, or 10,900 acres, of Otoe County is forested. Small, irregular tracts of woodland are scattered throughout the county, mainly in the valleys of streams and on the edges of adjoining uplands. Only a small part of the woodland is managed for commercial wood production. Most of the woodland is in private ownership, generally taking up a small acreage of the farm unit.

Since 1955, woodland acreage has declined by about 34 percent. Most of this decline is attributable to the clearing of woodland and its conversion to cropland.

Sawtimber consists of 36 percent bur oak and white oak, 16 percent eastern cottonwood, 10 percent northern red oak and black oak, 6 percent green ash, 5 percent common hackberry, 4 percent American basswood, 3.5 percent black walnut, and 19.5 percent American elm, black willow, silver maple, red mulberry, boxelder, honeylocust, bitternut and shagbark hickory, and osageorange. Most of these trees, especially the oaks, eastern cottonwood, black walnut, green ash, and hickories have commercial value for wood products.

Most of the soils in Otoe County have good potential for the production of sawtimber, firewood, Christmas trees, and other wood products, but most of these soils are used for cropland and are unlikely to be converted to the production of wood products. Soils on bottom lands along rivers and streams could produce high-value wood products within a short period of time, in contrast to the low-value, long-term rotation products produced on the upland soils.

windbreaks and environmental plantings

Keith A. Ticknor, forester, Soil Conservation Service, prepared this section.

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

A high percentage of the farmsteads in Otoe County have trees around them that were present when the farmstead was established or have been planted since (fig. 14). Planting trees around the farmstead is a continual process because old trees pass maturity and deteriorate, and some trees are lost through disease or insect damage.

For windbreaks to fulfill their intended purpose, species of trees or shrubs that are adapted to the soils in the area must be selected. Matching appropriate trees with the soil type is the first step towards insuring survival and maximum growth. Permeability, available water capacity, and soil fertility are characteristics that also affect the rate of growth of trees and shrubs in windbreaks.

Trees are easy to establish on most of the soils in Otoe County. Plant competition for moisture, nutrients, and sunlight causes most failures in windbreak plantings. Proper site preparation before planting and controlling weeds and other competing plants after planting are the major concerns in establishing and managing a windbreak.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery.

recreation

Robert O. Koerner, biologist, Soil Conservation Service, prepared this section.

Recreation facilities in Otoe County are diverse.

Riverview Park in Nebraska City has a picnic area and provides access to the Missouri River for boating. Arbor Lodge State Historical Park provides areas for hiking, nature study, birdwatching, and picnicking. Almost every tree that will grow in Nebraska has been planted on the lodge grounds. Nearby, Steinhart Park has a golf course, a museum, and a large picnic area.

The town of Syracuse has a golf course and a park. The Little Nemaha Wayside Area by Unadilla and the town parks in Douglas and Palmyra have playgrounds and picnic areas.

Sportsmen's Park and Centennial Lake have been developed mainly for fishing and picnicking. Many other farm ponds or small lakes in the county are used for fishing, hunting, and water sports.

The soils of the survey area are rated in table 8 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water

Figure 14.—Conifers are the most effective trees in this windbreak, which protects the buildings and livestock from wind and snow.

impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 8, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 8 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 11 and interpretations for dwellings without basements and for local roads and streets in table 10.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

wildlife habitat

Soils affect the kind and amount of vegetation that is available to wildlife as food and cover. They also affect the construction of water impoundments. The kind and abundance of wildlife depend largely on the amount and distribution of food, cover, and water (fig. 15). Wildlife habitat can be created or improved by planting appropriate vegetation, by maintaining the existing plant cover, or by promoting the natural establishment of desirable plants.

In table 9, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, grain sorghum, and soybeans.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are reed canarygrass, smooth brome, clover, and alfalfa.

Wild herbaceous plants are native or naturally established grasses and forbs, including weeds. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, switchgrass, sunflower, smartweed, giant ragweed, and foxtails.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil

Figure 15.—This area provides grass cover for pheasant, quail, mourning dove, and other upland game birds.

properties and features that affect the growth of hardwood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, dogwood, cottonwood, chokecherry, wild plum, gooseberry, black walnut, and mulberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and skunkbush sumac.

Coniferous plants furnish browse and seeds. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, cedar, and juniper.

Shrubs are bushy woody plants that produce fruit, buds, twigs, bark, and foliage. Soil properties and features that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and soil moisture. Examples of shrubs are American plum, chokecherry, buckbrush, and sumac.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are

texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness. Examples of wetland plants are smartweed, reed canarygrass, cordgrass, rushes, sedges, and cattails.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include bobwhite quail, pheasant, meadowlark, mourning dove, field sparrow, killdeer, cottontail rabbit, and coyote.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include songbirds, woodpeckers, squirrels, opossum, raccoon, white-tailed deer, and skunks.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, redwing blackbirds, shore birds, muskrat, mink, and beaver.

Habitat for rangeland wildlife consists of areas of shrubs and wild herbaceous plants. Wildlife attracted to rangeland include coyote, white-tailed deer, and meadowlark.

kinds of wildlife by soil association

Robert O. Koerner, biologist, Soil Conservation Service, prepared this section.

The six soil associations in Otoe County are discussed in relation to wildlife in the following paragraphs.

The Pawnee-Morrill-Shelby association consists of sloping and steep soils along the sides of drainageways. It includes patches of native grassland and woodland interspersed with cropland and pastureland. There are many kinds of wildlife in this association such as deer, pheasant, bobwhite quail, mourning dove, cottontail rabbit, tree squirrels, raccoon, coyote, hawks, owls, and songbirds. During the spring and fall migration periods, the watershed lakes and farm ponds in the association are used by waterfowl (fig. 16).

The Zook-Nodaway-Judson association consists of soils on bottom lands, foot slopes, and terraces. It includes the drainageways of the Little Nemaha River and its tributaries. The channels and immediate streambanks provide habitat for mink, muskrat, and beaver. Small shrubby and grassy areas provide cover for bobwhite quail. The bottom lands adjacent to the drainageways are mostly in cultivated crops such as corn, grain sorghum, and soybeans. These areas, adjacent to escape cover along the streams, provide food for many kinds of wildlife.

The Sharpsburg and Wymore associations are on the highest elevations in the county and have nearly level to rolling topography characterized by grassed waterways and terraced fields. Most of the acreage is in grain sorghum, corn, wheat, soybeans, alfalfa, clover, and other crops. Openland wildlife species such as pheasant, bobwhite quail, mourning dove, and songbirds are dominant.

The Marshall-Monona-Ponca association has rolling and steep topography. It takes in numerous small drainageways, fields of corn and soybeans, and a narrow wooded bluff that breaks to the bottom land of the Missouri River. Deer, bobwhite quail, cottontail rabbit, tree squirrels, coyote, raccoon, opossum, hawks, owls, and songbirds are dominant in this association.

The Haynie-Onawa-Albaton association includes the bottom lands of the Missouri River and some small lakes, some intermittent lakes, and marshy areas in old river channels. Areas along the lakes, channels, and immediate streambanks of the river provide riparian habitat for muskrat, mink, beaver, ducks, and shore birds. Areas of corn and soybeans interspersed with patches of grassland and woodland provide a diversity of habitats. Other kinds of wildlife include white-tailed deer, tree squirrels, bobwhite quail, mourning dove, coyote, and many songbirds. During the spring and fall migration periods, the lakes and streams and marshy areas are used by waterfowl.

engineering

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 or 6 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not

Figure 16.—Geese and ducks use watershed lakes and adjoining harvested grain fields during migration.

eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 to 6 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems,

ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

building site development

Table 10 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 or 6 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 to 6 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity.

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock or to a cemented pan, the available water capacity in the upper 40 inches, and the content of salts, sodium, and sulfidic materials affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

sanitary facilities

Table 11 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 11 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site features are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 24 and 72 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils.

Permeability, a high water table, depth to bedrock or to a cemented pan, and flooding affect absorption of the effluent. Large stones and bedrock or a cemented pan interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 4 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to filter the effluent effectively. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 11 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 11 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock or to a cemented pan, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, soil reaction, and content of salts and sodium affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 6 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

construction materials

Table 12 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill and topsoil. They are rated as a probable or improbable source of sand and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 or 6 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 or 6 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering index properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and gravel are natural aggregates suitable for commercial use with a minimum of processing. Sand and gravel are used in many kinds of construction. Specifications for each use vary widely. In table 12, only the probability of finding material in suitable quantity is evaluated. The suitability of the material for specific purposes is not evaluated, nor are factors that affect excavation of the material.

The properties used to evaluate the soil as a source of sand or gravel are gradation of grain sizes (as indicated by the engineering classification of the soil), the thickness of suitable material, and the content of rock fragments. Kinds of rock, acidity, and stratification are given in the soil series descriptions. Gradation of grain sizes is given in the table on engineering index properties.

A soil rated as a probable source has a layer of clean sand or gravel or a layer of sand or gravel that is up to 12 percent silty fines. This material must be at least 3 feet thick and less than 50 percent, by weight, large stones. All other soils are rated as an improbable source. Coarse fragments of soft bedrock, such as shale and siltstone, are not considered to be sand and gravel.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are low in content of soluble salts, are naturally fertile or respond well to fertilizer, and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel, stones, or soluble salts, or soils that have slopes of 8 to 15 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel, stones, or soluble salts, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

water management

Table 13 gives information on the soil properties and site features that affect water management. The degree and kind of soil limitations are given for pond reservoir areas and embankments, dikes, and levees. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and are easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increase in construction costs, and possibly increased maintenance are required.

This table also gives for each soil the restrictive features that affect drainage, irrigation, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders, organic matter, or salts or sodium. A high water table affects the amount of usable material. It also affects trafficability.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock, to a cemented pan, or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers; and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock or to a cemented pan, large stones, slope, and the hazard of cutbanks caving. The productivity of the soil after drainage is adversely affected by extreme acidity or by toxic substances in the root zone, such as salts, sodium, or sulfur. Availability of drainage outlets is not considered in the ratings.

Irrigation is the controlled application of water to supplement rainfall and support plant growth. The design and management of an irrigation system are affected by depth to the water table, the need for drainage, flooding, available water capacity, intake rate, permeability, erosion hazard, and slope. The construction of a system is affected by large stones and depth to bedrock or to a cemented pan. The performance of a system is affected by the depth of the root zone, the amount of salts or sodium, and soil reaction.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock or to a cemented pan affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock or to a cemented pan affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, toxic substances such as salts or sodium, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

engineering index properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 or 6 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and their morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance. In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. In this table, the estimated clay content of each major soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The amount and kind of clay greatly affect the fertility and physical condition of the soil. They determine the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, permeability, and plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earth-moving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3 bar moisture tension. Weight is determined after drying the soil at 105 degrees C. In this table, the estimated moist bulk density of each major soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. A bulk density of more than 1.6 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Salinity is a measure of soluble salts in the soil at saturation. It is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25 degrees C. Estimates are based on field and laboratory measurements at representative sites of nonirrigated soils. The salinity of irrigated soils is affected by the quality of the irrigation water and by the frequency of water application. Hence, the salinity of soils in individual fields can differ greatly from the value given in the table. Salinity affects the suitability of a soil for crop production, the stability of soil if used as construction material, and the potential of the soil to corrode metal and concrete.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69.

The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Organic matter is the plant and animal residue in the soil at various stages of decomposition.

In table 15, the estimated content of organic matter of the plow layer is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter of a soil can be maintained or increased by returning crop residue to the soil. Organic matter affects the available water capacity, infiltration rate, and tilth. It is a source of nitrogen and other nutrients for crops.

soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams, by runoff from adjacent slopes, or by tides. Water standing for short periods after rainfall or snowmelt is not considered flooding, nor is water in swamps and marshes.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months;

November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay deposited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16.

An *apparent* water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. A *perched* water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Only saturated zones within a depth of about 6 feet are indicated. A plus sign preceding the range in depth indicates that the water table is above the surface of the soil. The first numeral in the range indicates how high the water rises above the surface. The second numeral indicates the depth below the surface.

Depth to bedrock is given if bedrock is within a depth of 5 feet. The depth is based on many soil borings and on observations during soil mapping. The rock is specified as either soft or hard. If the rock is soft or fractured, excavations can be made with trenching machines, backhoes, or small rippers. If the rock is hard or massive, blasting or special equipment generally is needed for excavation.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low*, *moderate*, or *high*, is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

engineering index test data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. The pedons are typical of the series and are described in the section "Soil series and their morphology." The soil samples were tested by the Nebraska Department of Roads.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145-73 (AASHTO), D 3282 (ASTM); Unified classification—D 2487-69 (1975) (ASTM); Mechanical analysis—T 88-76 I (AASHTO), D 2217 (ASTM); Liquid limit—T 89-76 I (AASHTO), D 423 (ASTM); Plasticity index—T 90-70 (AASHTO), Specific gravity—T—100-75 (AASHTO).

classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*9*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Udoll (*Ud*, meaning humid, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Argiudolls (*Argi*, meaning a horizon with clay accumulation, plus *udolls*, the suborder of the Mollisols that have a udic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Argiudolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, montmorillonitic, mesic Typic Argiudolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

soil series and their morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*7*). Many of the technical terms used in the descriptions are defined in Soil Taxonomy (*9*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Detailed soil map units."

Albaton series

The Albaton series consists of deep, poorly drained, very slowly permeable soils that formed in calcareous clayey alluvium. Albaton soils are on bottom lands and are nearly level. Slopes range from 0 to 1 percent.

Albaton soils are commonly adjacent to Haynie and Onawa soils. Albaton soils are more clayey than Haynie soils, which are at slightly higher elevations. The clayey layers are thicker in Albaton soils than in the Onawa soils, which are loamy below a depth of about 20 inches.

Typical pedon of Albaton silty clay, 0 to 1 percent slopes, 1,060 feet east and 1,230 feet north of the southwest corner of sec. 14, T. 8 N., R. 14 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) dry; moderate fine and very fine angular blocky structure; firm, very hard; slight effervescence; mildly alkaline; clear smooth boundary.

C1—9 to 18 inches; mixed dark grayish brown (2.5Y 4/2) and very dark gray (10YR 3/1) silty clay, gray (5Y 5/1) and dark gray (5Y 4/1) dry; few medium prominent dark brown (7.5YR 4/4) mottles; moderate fine angular blocky structure; common, strong angular planes of cleavage and pressure faces; very firm; slight effervescence; mildly alkaline; clear smooth boundary.

C2g—18 to 60 inches; mixed dark grayish brown (2.5Y 4/2), olive gray (5Y 5/2), and dark gray (5Y 4/1) silty clay, gray (5Y 5/1), (5Y 6/1) dry; common, coarse prominent dark brown (7.5YR 4/4) and strong brown (7.5YR 5/6) mottles; massive; many strong angular planes of cleavage and angular pressure faces; very firm; slight effervescence; mildly alkaline.

The solum is 4 to 10 inches thick, and the A horizon is 4 to 10 inches thick.

The A horizon has color value of 3 or 4 (4 or 5, dry) and chroma of 1 or 2. It is dominantly silty clay, but the range includes silty clay loam. Reaction is moderately alkaline or mildly alkaline. The C horizon has value of 4 or 5 (5 or 6, dry), and it has thin strata that have value of 2 or 3 (3 or 4, dry). The texture is silty clay, but there can be coarser textures below a depth of 40 inches. Reaction is mildly alkaline or moderately alkaline.

Benfield series

The Benfield series consists of moderately deep, well drained, slowly permeable soils that formed in variegated, calcareous shale. The soils are on side slopes of uplands. Slopes range from 6 to 20 percent.

Benfield soils in Otoe County are in a more moist region than is normal for the series. The moist conditions, however, do not affect the use or behavior of these soils.

Benfield soils are on the same landscape as Kipson soils. Benfield soils are deeper to shale than Kipson soils and have a clayey argillic horizon, unlike Kipson soils.

Typical pedon of Benfield silty clay loam, in an area of Kipson-Benfield complex, 6 to 20 percent slopes, 1,350 feet south and 150 feet east of the northwest corner of sec. 19, T. 8 N., R. 11 E.

A1—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; weak very fine and fine subangular blocky structure; friable; hard; mildly alkaline; clear smooth boundary.

B21t—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; moderate fine angular blocky structure; firm; mildly alkaline; gradual smooth boundary.

B22t—12 to 24 inches; brown (7.5YR 4/2) silty clay, pale brown (10YR 6/3) dry; moderate fine and medium angular blocky structure; firm; mildly alkaline; gradual smooth boundary.

B3—24 to 36 inches; brown (7.5YR 5/4) silty clay, light brown (7.5YR 6/4) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; weak medium and coarse angular blocky structure; firm; common small lime concretions in lower part; violent effervescence in concretions only; mildly alkaline; clear smooth boundary.

Cr—36 to 60 inches; light yellowish brown (2.5Y 6/4) clayey and silty shale, pale yellow (2.5Y 7/4) dry; few fine faint grayish brown (2.5Y 5/2) mottles; massive; violent effervescence; mildly alkaline.

The solum is 20 to 40 inches thick, which is the same as the depth to free carbonates. The mollic epipedon is 10 to 20 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. Reaction ranges from slightly acid to mildly alkaline. The B horizon is clay or silty clay. The Cr horizon is the same color as the underlying shale and includes hue of 5YR to 5Y, value of 5 or 6 (6 or 7, dry), and chroma of 2 to 4. It is mildly alkaline or moderately alkaline.

Burchard series

The Burchard series consists of deep, well drained soils that have moderately slow permeability. These soils formed in firm, loamy, calcareous glacial deposits. They are on side slopes on uplands. Slopes range from 9 to 15 percent.

Burchard soils are similar to Shelby soils and are commonly adjacent to Pawnee, Shelby, and Steinauer soils. They are in the same general position on the landscape as Shelby and Steinauer soils and are commonly in places downslope from Pawnee soils. Carbonates are not leached so deep in Burchard soils as in Shelby soils. Burchard soils have a mollic epipedon and do not have carbonates near the surface, unlike Steinauer soils. Burchard soils have a less clayey B horizon than Pawnee soils.

Typical pedon of Burchard clay loam, in an area of Shelby and Burchard clay loams, 9 to 15 percent slopes, 250 feet north and 325 feet west from southeast corner of sec. 10, T. 8 N., R 11 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; moderate fine subangular blocky structure parting to moderate

very fine granular; friable; hard; slightly acid; gradual smooth boundary.

B1—8 to 14 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; neutral; gradual wavy boundary.

B2t—14 to 23 inches; brown (10YR 4/3) clay loam, pale brown (10YR 6/3) dry; moderate fine subangular blocky structure; firm; thin patchy clay films; strong effervescence; mildly alkaline; gradual smooth boundary.

B3—23 to 30 inches; grayish brown (10YR 5/2) clay loam, light gray (10YR 7/2) dry; common medium distinct dark yellowish brown (10YR 4/4) mottles; weak medium angular blocky structure; firm; common lime concretions and soft accumulations of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C—30 to 60 inches; mottled grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) clay loam, light gray (2.5Y 7/2) and light yellowish brown (10YR 6/4) dry; massive; many moderate angular planes of cleavage; firm; strong effervescence; moderately alkaline; common lime concretions and few soft accumulations of lime.

The solum is about 24 to 40 inches thick. The mollic epipedon is 8 to 18 inches thick. The depth to free carbonates ranges from 13 to 30 inches. The content of pebbles and cobblestones on the surface and in the profile ranges from 1 to 5 percent, by volume.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam. Reaction ranges from medium acid to neutral. The B2t horizon has value of 3 to 5 (5 or 6, dry) and chroma of 3 or 4. The C horizon has value of 5 or 6 (6 or 7, dry) and chroma of 2 to 6. It is mildly alkaline or moderately alkaline. The calcium carbonate equivalent ranges from 7 to 15 percent in the calcareous part of the B horizon and in the C horizon.

Colo series

The Colo series consists of deep, somewhat poorly drained and poorly drained, moderately permeable soils. Colo soils formed in silty alluvium. They are on bottom lands and are nearly level. Slopes range from 0 to 2 percent.

Colo soils are commonly adjacent to Judson, Kennebec, and Nodaway soils. Colo soils are more poorly drained than the associated soils. In addition, Colo soils do not have fine stratification like Nodaway soils.

Typical pedon of Colo silty clay loam, 0 to 1 percent slopes, 520 feet west and 200 feet north of southeast corner of the northwest quarter of sec. 35, T. 9 N., R. 9 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable, hard; slightly acid; abrupt smooth boundary.

A12—7 to 14 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

A13—14 to 52 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium angular blocky structure parting to moderate very fine and fine subangular blocky; friable; slightly acid; gradual smooth boundary.

Cg—52 to 60 inches; dark gray (10YR 4/1) silty clay loam, gray (10YR 5/1) dry; common fine faint dark grayish brown (10YR 4/2) mottles; moderate fine and medium angular blocky structure; firm; neutral.

The solum is 36 to 54 inches thick, and so is the A horizon.

The A horizon has color value of 2 or 3 (3 or 4, dry), chroma of 0 or 1, and hue of 10YR or N. It is dominantly silty clay loam, but in some places the upper part of the Ap or A1 horizon is silt loam. Some pedons have stratified, very dark brown, very dark grayish brown, and dark grayish brown silt loam overwash 6 to 20 inches thick over the original A horizon. The A horizon is slightly acid, but it ranges from neutral to medium acid. The C horizon has value of 4, but it can have value of 3.

Some pedons have mottles of high value and chroma below a depth of 36 inches. Some pedons have few small lime concretions below a depth of 50 inches. Below a depth of 50 inches in some places, the texture ranges from silty clay to loam.

Dickinson series

The Dickinson series consists of deep, well drained and somewhat excessively drained soils that formed in moderately coarse material. Permeability is moderately rapid in the solum and rapid in the underlying material. These soils are on side slopes of uplands. Slopes range from 6 to 20 percent.

Dickinson soils are commonly adjacent to Burchard, Malcolm, Mayberry, Morrill, Pawnee, and Shelby soils. Dickinson soils are more sandy than these soils.

Typical pedon of Dickinson fine sandy loam, 6 to 11 percent slopes, 845 feet north and 580 feet west of middle of sec. 25, T. 7 N., R. 9 E.

A1—0 to 12 inches, very dark brown (10YR 2/2) fine sandy loam, dark gray (10YR 4/1) dry; weak medium and coarse blocky structure parting to weak fine granular; very friable, soft; slightly acid; gradual smooth boundary.

B2—12 to 24 inches; very dark grayish brown (10YR 3/2) fine sandy loam, grayish brown (10YR 5/2) dry; weak fine and medium subangular blocky structure;

very friable; slightly acid; considerable mixing with the above horizon caused by rodents; gradual wavy boundary.

B3—24 to 38 inches; dark grayish brown (10YR 4/2) fine sandy loam, light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; very friable; medium acid; gradual smooth boundary.

C—38 to 60 inches; yellowish brown (10YR 5/4) loamy fine sand, very pale brown (10YR 7/4) dry; single grain; very friable; medium acid.

The solum is 24 to 45 inches thick. The mollic epipedon is 10 to 24 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly fine sandy loam, but the range includes sandy loam and loam. The B2 horizon has value of 3 to 5 (5 or 6, dry) and chroma of 2 to 4 in hue of 10YR or 7.5YR. It is fine sandy loam or sandy loam. The B3 and C horizons range from fine sandy loam to sand.

Dow series

The Dow series consists of deep, well drained and somewhat excessively drained, moderately permeable soils that formed in calcareous grayish loess. Dow soils are on side slopes on uplands. Slopes range from 5 to 17 percent.

Dow soils are commonly adjacent to Marshall, Monona, and Ponca soils. They are on side slopes and in areas downslope from the adjoining Marshall and Monona soils on ridgetops. Dow soils are in the same position on the landscape as Ponca soils. Dow soils have weak profile development, and unlike the closely associated soils they do not have a mollic epipedon and are not leached of carbonates.

Typical pedon of Dow silt loam, in an area of Ponca-Dow silt loams, 11 to 17 percent slopes, eroded, 635 feet east and 200 feet south of the center of sec. 17, T. 8 N., R. 14 E.

Ap1—0 to 6 inches; grayish brown (2.5Y 5/2) silt loam, light brownish gray (2.5Y 6/2) dry; few medium distinct reddish brown (5YR 4/4) mottles; weak coarse and medium blocky structure parting to weak fine subangular blocky; friable; few iron concretions (pipestems); few lime concretions; strong effervescence; mildly alkaline; abrupt smooth boundary.

C1—6 to 14 inches; grayish brown (2.5Y 5/2) silt loam, light gray (2.5Y 7/2) dry; many coarse prominent reddish brown (5YR 4/4) mottles; weak coarse blocky structure; friable; few iron concretions (pipestems); few lime concretions; strong effervescence; moderately alkaline; gradual smooth boundary.

C2—14 to 28 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; few coarse prominent reddish brown (5YR 4/4) mottles; massive; friable; few iron concretions (pipestems); common lime concretions; many threads of soft lime; strong effervescence; moderately alkaline; gradual smooth boundary.

C3—28 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, light gray (2.5Y 7/2) dry; few coarse prominent reddish brown (5YR 4/4) mottles; massive; friable; few iron concretions; common threads of soft lime; slight effervescence; moderately alkaline.

The solum is 4 to 10 inches thick, and generally its thickness corresponds to that of the A horizon. The depth to free carbonates ranges from 0 to 10 inches.

The A horizon has color value of 3 through 5 (4 through 6, dry) and chroma of 2 through 4. Reaction ranges from neutral to moderately alkaline. In some places, the A horizon does not have lime concretions. Except for the high chroma mottles, the matrix of the C horizon has value of 5 or 6 (6 or 7, dry) and chroma of 2 in hue of 2.5Y or 5Y.

Haynie series

The Haynie series consists of deep, moderately well drained, moderately permeable soils that formed in calcareous loamy and silty alluvium. They are on bottom lands and are nearly level. Slopes range from 0 to 2 percent.

Haynie soils are commonly adjacent to Albaton, Onawa, and Sarpy soils. Haynie soils are less clayey than Albaton and Onawa soils and are at a slightly higher elevation than Albaton soils. Haynie soils are silty, and the Sarpy soils are sandy.

Typical pedon of Haynie silt loam, 0 to 2 percent slopes, 680 feet north and 3,640 feet east of southwest corner of sec. 31, T. 8 N., R. 15 E.

Ap—0 to 7 inches; very dark grayish brown (2.5Y 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium blocky structure parting to weak fine subangular blocky; very friable, slightly hard; strong effervescence; mildly alkaline; clear smooth boundary.

C—7 to 60 inches; stratified very dark grayish brown (2.5Y 3/2), dark grayish brown (2.5Y 4/2), and grayish brown (2.5Y 5/2) silt loam and very fine sandy loam, grayish brown (2.5Y 5/2) and light brownish gray (2.5Y 6/2) dry; common fine distinct brown (7.5YR 4/4) mottles; massive; common horizontal planes of cleavage caused by stratification; very friable; strong effervescence; moderately alkaline.

The solum is 6 to 10 inches thick, and so is the A horizon.

Texture of the A horizon is silt loam or very fine sandy loam. Colors are in hue of 10YR or 2.5Y. The C horizon has hue of 10YR or 2.5Y, value of 3 through 5, and chroma of 2 or 3. The C horizon in some places has thin strata of fine sandy loam.

Judson series

The Judson series consists of deep, well drained, moderately permeable soils. These soils formed in silty sediment that eroded from dark colored soils on adjacent uplands. They are on foot slopes and stream terraces. Slopes range from 0 to 6 percent.

Judson soils are similar to Kennebec soils and are commonly adjacent to Colo and Nodaway soils on bottom lands. Judson soils are better drained than Kennebec soils. They are less stratified and better drained than Nodaway and Colo soils.

Typical pedon of Judson silt loam, 2 to 6 percent slopes, 680 feet north and 200 feet west of southeast corner of sec. 14, T. 9 N., R. 11 E.

Ap—0 to 10 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak medium blocky structure parting to weak very fine granular structure; friable, slightly hard; neutral; abrupt smooth boundary.

A12—10 to 21 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; moderate fine granular structure; friable; slightly acid; gradual smooth boundary.

A3—21 to 34 inches; very dark brown (10YR 2/2) silt loam, dark grayish brown (10YR 4/2) dry; strong medium granular structure; friable; slightly acid; gradual smooth boundary.

B21—34 to 47 inches; dark brown (10YR 3/3) silty clay loam, dark brown (10YR 4/3) dry; faces of peds very dark grayish brown (10YR 3/2) moist and dark grayish brown (10YR 4/2) dry; moderate fine and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B22—47 to 55 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; few fine faint dark yellowish brown (10YR 3/4) mottles; moderate medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—55 to 60 inches; mottled dark yellowish brown (10YR 3/4) and very dark grayish brown (2.5Y 3/2) silty clay loam, dark yellowish brown (10YR 4/6) and grayish brown (10YR 5/2) dry; weak coarse and medium prismatic structure; firm; neutral.

The solum is 40 to 60 inches thick. The mollic epipedon is 30 to more than 50 inches thick. The interior color of the peds, beginning at a depth of 36 inches or less, has value of 3 or 4 (4 or 5, dry) and chroma of 3 or 4. In some places, the color has value of 3 to a depth of 60 inches.

The A horizon is 20 to 36 inches thick. The A horizon is silt loam or silty clay loam, and reaction is slightly acid or neutral. The clay content of the B horizon ranges from 30 to 35 percent.

Kennebec series

The Kennebec series consists of deep, moderately well drained, moderately permeable soils that formed in silty alluvium. These soils are on bottom lands. Slopes range from 0 to 4 percent.

Kennebec soils are similar to Judson soils and are commonly adjacent to Colo, Nodaway, and Zook soils. Kennebec soils are better drained than Colo soils and are not so finely stratified as Nodaway soils. Kennebec soils are better drained and less clayey than Zook soils. Judson soils are better drained than Kennebec soils.

Typical pedon of Kennebec silt loam, 0 to 1 percent slopes, 1,450 feet north and 100 feet east of southwest corner of sec. 25, T. 7 N., R. 12 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silt loam, dark gray (10YR 4/1) dry; weak medium blocky structure parting to weak fine granular structure; friable, slightly hard; slightly acid; clear smooth boundary.

A12—7 to 18 inches; black (10YR 2/1) silt loam, very dark gray (10YR 3/1) dry; weak fine subangular blocky and weak fine granular structure; friable; slightly acid; gradual smooth boundary.

A13—18 to 42 inches; very dark gray (10YR 3/1) silt loam, gray (10YR 5/1) dry; weak fine subangular blocky structure; friable; slightly acid; clear smooth boundary.

C—42 to 60 inches; very dark grayish brown (2.5Y 3/2) silt loam, grayish brown (10YR 5/2) dry; common thin strata of grayish brown (2.5Y 5/2, moist) silt loam; few fine distinct dark yellowish brown (10YR 4/4) mottles; massive; very friable; neutral.

The solum and mollic epipedon are 36 to more than 50 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 to 3. It is dominantly silt loam, but the range includes silty clay loam. The A horizon is slightly acid or neutral. Some pedons have very dark grayish brown and dark grayish brown stratified silt loam overwash 6 to 18 inches thick over the original A horizon. The C horizon has value of 3 or 4 (4 or 5, dry) and chroma of 1 or 2. It is dominantly silt loam or silty clay loam to a depth of 40 inches. Below a depth of 40 inches, in some places, there is a buried soil that ranges from very fine sandy loam to silty clay. The C horizon is neutral or slightly acid.

Kipson series

The Kipson series consists of shallow, moderately permeable soils that formed in calcareous shale. These soils are somewhat excessively drained or excessively drained and are on side slopes on uplands. Slopes range from 6 to 70 percent.

Kipson soils in Otoe County are in a region that is wetter than is normal for the series. The wet conditions, however, do not affect the use or behavior of these soils.

Kipson soils are on the same landscape as Benfield soils. They are commonly adjacent to Malcolm, Mayberry, Pawnee, and Wymore soils. Kipson soils are shallower to shale than the associated soils.

Typical pedon of Kipson channery silt loam, in an area of Kipson-Benfield complex, 6 to 20 percent slopes, 1,050 feet south and 150 feet east of the northwest corner of sec. 19, T. 8 N., R. 11 E.

A1—0 to 8 inches; very dark gray (10YR 3/1) channery silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; hard, friable; many dominantly flat fragments of limestone rock, 10 percent of which are less than 3 inches in size, 10 percent are 3 to 6 inches long, and 5 percent are 6 to 15 inches long; violent effervescence; moderately alkaline; gradual wavy boundary.

AC—8 to 15 inches; dark grayish brown (2.5Y 4/2) silt loam, grayish brown (2.5Y 5/2) dry; moderate very fine subangular blocky structure; friable; about 10 percent limestone fragments less than 3 inches in size; violent effervescence; moderately alkaline; gradual wavy boundary.

C1—15 to 20 inches; light olive gray (5Y 6/2) shaly silt loam, light gray (5Y 7/2) dry; massive breaking to weak medium platy and moderate fine angular blocky fragments of shale; firm; about 10 percent of shale fragments are less than 3 inches in size; violent effervescence; moderately alkaline; gradual wavy boundary.

Cr—20 to 60 inches; olive (5Y 5/3) consolidated silty shale.

The solum is 8 to 20 inches thick.

The A horizon has value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly channery silt loam, but the range includes silt loam and silty clay loam. The content of coarse fragments up to 6 inches in size ranges from 0 to 25 percent, by volume. The content of flagstone greater than 6 inches in size ranges from 0 to 5 percent, by volume. The AC horizon has color in hue of 7.5YR to 2.5Y. It is silt loam or silty clay loam. The Cr or C horizon has hue of 7.5YR to 5Y, value of 5 or 6 (6 or 7, dry), and chroma of 2 to 4.

Malcolm series

The Malcolm series consists of deep, well drained and somewhat excessively drained, moderately permeable soils that formed in grayish silty material. The soils are on uplands near areas of glacial soils. Slopes range from 5 to 25 percent.

Malcolm soils are commonly adjacent to Dickinson soils. Malcolm soils are less sandy than Dickinson soils.

Typical pedon of Malcolm silt loam, 5 to 11 percent slopes, 1,670 feet north and 125 feet east of southwest corner of sec. 14, T. 7 N., R. 10 E.

A1—0 to 7 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine and medium subangular blocky structure parting to weak fine granular; friable, hard; slightly acid; gradual smooth boundary.

B21t—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; moderate very fine and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B22t—12 to 20 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; some very dark grayish brown organic or clay coatings on faces of peds; strong very fine and fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B3—20 to 28 inches; brown (10YR 4/3) silty clay loam, pale brown (10YR 6/3) dry; few coarse distinct strong brown (7.5YR 5/8) mottles; moderate very fine and fine subangular blocky structure; friable; few iron concretions; medium acid; clear smooth boundary.

C—28 to 60 inches; light brownish gray (2.5Y 6/2) coarse silt loam, white (2.5Y 8/2) dry; massive; common horizontal planes of cleavage; very friable; medium acid.

The solum is 17 to 36 inches thick. The mollic epipedon is 7 to 15 inches thick.

The A horizon has color value of 2 or 3 (3 or 4, dry) and chroma of 1 or 2. It is dominantly silt loam, but the range includes loam. In eroded areas, the A horizon may be silty clay loam. Reaction is slightly acid or medium acid. The B2 horizon has value of 4 or 5 and chroma of 2 or 3 in hue of 10YR and 2.5Y. It is dominantly silty clay loam, but the range includes loam or silt loam. The B2 horizon is medium acid or slightly acid. The C horizon has value of 6 or 7, chroma of 1 or 2, and hue of 2.5Y, but the range includes chroma of 3 and hue of 10YR through 5Y. The C horizon is dominantly coarse silt loam and very fine sandy loam, but in some places it has thin

stratified layers of silty clay loam and fine sandy loam. The C horizon is slightly acid or medium acid.

The thickness and darkness of the A horizon and of the upper part of the B horizon of map unit MaD2 are less than that defined as the range for the series. These differences, however, do not affect the use or behavior of this soil.

Marshall series

The Marshall series consists of deep, well drained soils that have moderate permeability. Marshall soils formed in loess and are on uplands. Slopes range from 2 to 17 percent.

Marshall soils are commonly adjacent to other upland soils that formed in loess such as Monona, Ponca, and Sharpsburg soils. Marshall soils are more clayey than Monona soils. The depth to free carbonates in Marshall soils is greater than in Ponca soils. Marshall soils are less clayey than Sharpsburg soils, and they do not have an argillic horizon.

Typical pedon of Marshall silty clay loam, 2 to 5 percent slopes, 230 feet south and 240 feet west from northeast corner of southeast quarter of sec. 11, T. 9 N., R. 13 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; weak coarse and medium blocky structure parting to weak fine granular; friable; medium acid; abrupt smooth boundary.

B1—7 to 12 inches; very dark grayish brown (10YR 3/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak coarse and medium blocky structure parting to weak very fine subangular blocky; some mixing of material from horizon below by rodents and burrowing animals; friable; medium acid; abrupt smooth boundary.

B21—12 to 20 inches; dark brown (10YR 3/3) silty clay loam, brown (10YR 4/3) dry; moderate very fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B22—20 to 36 inches; brown (10YR 4/3) silty clay loam, yellowish brown (10YR 5/4) dry; moderate fine and very fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

B3—36 to 46 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; few fine faint dark yellowish brown (10YR 4/6) and grayish brown (10YR 5/2) relict mottles; weak medium and fine subangular blocky structure; friable; slightly acid; gradual smooth boundary.

C—46 to 60 inches; mottled dark yellowish brown (10YR 4/6) and grayish brown (10YR 5/2) silty clay loam, brownish yellow (10YR 6/6) and light brownish gray (10YR 6/2) dry; weak coarse prismatic structure; friable; neutral.

The solum is 40 to 70 inches thick. The mollic epipedon is 10 to 20 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly silty clay loam, but the range includes silt loam. The B2 horizon has value of 3 through 5 (4 or 5, dry) and chroma of 3 or 4. The clay content ranges from 28 to 35 percent. The A and B horizons are slightly acid or medium acid. The C horizon has color value of 4 or 5 (5 or 6, dry), chroma of 2 through 6, and hue of 10YR through 5Y.

The darkness of the A horizon and of the upper part of the B horizon of map unit MhD2 is less than that defined as the range for the series. This difference however, does not affect the use or behavior of this soil.

Mayberry series

The Mayberry series consists of deep, moderately well drained, slowly permeable soils on uplands. Mayberry soils formed in reddish to brownish, clayey, reworked glacial material. Slopes range from 3 to 9 percent.

Mayberry soils are similar to Pawnee soils and are commonly adjacent to Morrill, Pawnee, and Wymore soils. They are commonly in places upslope from Malcolm soils, are in the same general position on the landscape as Morrill and Pawnee soils, and are commonly in places downslope from Wymore soils. Mayberry soils are similar in color to Morrill soils, but their B horizon is more clayey. The texture of Mayberry soils is similar to that of Pawnee soils, but the B horizon is redder. Wymore soils formed in loess.

Typical pedon of Mayberry clay loam, 3 to 9 percent slopes, 1,060 feet north and 60 feet west of southeast corner of sec. 35, T. 7 N., R. 10 E.

Ap—0 to 6 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium and fine subangular blocky structure parting to moderate fine granular; friable, hard; slightly acid; gradual smooth boundary.

B1t—6 to 10 inches; dark brown (7.5YR 3/2) clay loam, brown (7.5Y 5/2) dry; moderate very fine and fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B21t—10 to 30 inches; dark reddish brown (5YR 3/4) clay, reddish brown (5YR 4/4) dry; common medium distinct dark red (2.5YR 3/6) and dark grayish brown (10YR 4/2) mottles; moderate fine and medium angular blocky structure; shiny faces on peds; very firm; slightly acid; gradual wavy boundary.

B22t—30 to 43 inches; brown (7.5YR 4/4) clay, brown (7.5YR 5/4) dry; few fine faint reddish brown (5YR 4/4) mottles; moderate medium and fine angular blocky structure; common large lime concretions; very firm; neutral; gradual wavy boundary.

B3—43 to 60 inches; mottled grayish brown (2.5Y 5/2) and brown (7.5YR 4/4) stratified silty clay and clay, light gray (2.5Y 7/2) and brown (7.5YR 5/4) dry;

moderate, medium, and fine angular blocky structure; very firm; shiny faces on peds; neutral; gradual wavy boundary.

C—60 to 80 inches; mottled yellowish brown (10YR 5/4), grayish brown (2.5Y 5/2), and dark reddish brown (5YR 3/4) stratified silty clay, loam, and sandy loam, light yellowish brown (10YR 6/4), light gray (10YR 7/2), and dark brown (7.5YR 4/4) dry; massive; some horizontal and vertical planes of cleavage; firm; neutral.

The solum is about 40 to 70 inches thick. The mollic epipedon is 10 to 16 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. This horizon is dominantly clay loam, but the range includes loam, silt loam, and clay. The reaction is slightly acid or medium acid. In areas of native sod, there is an A1 horizon up to 15 inches thick. The B2t horizon has value of 3 to 5 (4 to 6, dry), chroma of 2 to 4, and hue of 7.5YR and 5YR. The B2t horizon is typically clay, and less commonly silty clay or sandy clay. Reaction is slightly acid or neutral. In some pedons, there are bands of silt or sand in the lower part of the B horizon. The C horizon is variable in texture. In some pedons it is loamy or sandy material; in other pedons it is compact glacial deposits of firm clay loam.

The A horizon and the upper part of the B horizon of map unit MsC3 are lighter in color than is defined as the range for the series. This difference, however, does not affect the use or behavior of the soil.

Monona series

The Monona series consists of deep, well drained to excessively drained, moderately permeable soils that formed in loess. These soils are on uplands adjacent to the Missouri River. Slopes range from 2 to 70 percent.

Monona soils are commonly adjacent to Dow, Marshall, and Ponca soils. Unlike Dow soils, Monona soils do not have free carbonates, and they have a mollic epipedon and a B horizon. Carbonates are leached deeper in Monona soils than in Ponca soils. Monona soils are less clayey than Marshall soils.

Typical pedon of Monona silt loam, 2 to 5 percent slopes, 140 feet south and 140 feet east from northwest corner of northeast quarter of sec. 22, T. 8 N., R. 14 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam, dark grayish brown (10YR 4/2) dry; weak medium blocky structure parting to weak fine granular; friable, slightly hard; slightly acid; clear smooth boundary.

B1—7 to 12 inches; dark brown (10YR 3/3) silt loam, dark yellowish brown (10YR 4/4) dry; weak medium blocky structure parting to weak fine and very fine subangular blocky; friable; some mixing of material from adjoining horizons caused by rodents; slightly acid; gradual smooth boundary.

B2—12 to 36 inches; brown (10YR 4/3) silt loam, yellowish brown (10YR 5/4) dry; weak coarse prismatic structure parting to weak medium and fine subangular blocky; friable; common medium pores; slightly acid; gradual smooth boundary.

C1—36 to 54 inches; brown (10YR 5/3) silt loam, light yellowish brown (10YR 6/4) dry; common medium distinct dark brown (7.5YR 4/4) mottles; massive; some weak vertical planes of cleavage; common dark friable accumulations; many fine pores; neutral; gradual smooth boundary.

C2—54 to 60 inches; yellowish brown (10YR 5/4) silt loam, yellowish brown (10YR 6/4) dry; common medium distinct strong brown (7.5YR 5/6) and grayish brown (2.5Y 5/2) mottles; massive; friable; few dark accumulations; many fine pores; neutral.

The solum is 24 to 42 inches thick. The mollic epipedon is 10 to 16 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. Typically, the A horizon is slightly acid but ranges from medium acid to neutral. The B2 horizon has color value of 4 or 5 (5 or 6, dry) and chroma of 3 or 4. It is dominantly silt loam but the range includes silty clay loam that is less than 30 percent clay. Reaction is slightly acid but is neutral in some places. The C horizon has color value of 5 or 6 (6 or 7, dry) and chroma of 3 through 6. Reaction is neutral or mildly alkaline.

Morrill series

The Morrill series consists of deep, well drained soils that have moderately slow permeability. These soils formed in reddish or brownish loamy glacial deposits. They are on side slopes on uplands. Slopes range from 3 to 11 percent.

Morrill soils are similar to Burchard and Shelby soils and are commonly adjacent to Dickinson, Malcolm, and Mayberry soils. Morrill soils are more clayey than Dickinson soils, which formed in sandy material. Morrill soils have a redder B horizon than Burchard, Malcolm, and Shelby soils. Morrill soils are similar in color to Mayberry soils but have a less clayey B horizon.

Typical pedon of Morrill clay loam, 5 to 11 percent slopes, 1,600 feet north and 200 feet east of southwest corner, sec. 31, T. 7 N., R. 10 E.

A1—0 to 10 inches; dark brown (7.5YR 3/2) clay loam, dark brown (7.5YR 4/2) dry; weak coarse and medium blocky structure parting to weak fine granular; friable, slightly hard; medium acid; gradual smooth boundary.

B21t—10 to 14 inches; brown (7.5YR 4/4) clay loam, brown (7.5YR 5/4) dry; weak coarse and medium blocky structure parting to moderate medium and fine subangular blocky; friable; medium acid; gradual smooth boundary.

B22t—14 to 28 inches; reddish brown (5YR 4/4) clay loam, brown (7.5YR 5/4) dry; weak coarse and medium blocky structure parting to weak medium and fine subangular blocky; friable; medium acid; gradual smooth boundary.

B3—28 to 48 inches; yellowish red (5YR 4/6) clay loam, brown (7.5YR 5/4) dry; weak medium and coarse blocky structure; friable; medium acid; gradual wavy boundary.

C—48 to 60 inches; mottled brown (7.5YR 5/4) and dark brown (7.5YR 4/4) stratified sandy clay loam and sandy loam, light brown (7.5YR 6/4) and brown (7.5YR 5/4) dry; massive; friable; slightly acid.

The solum is 30 to 60 inches thick. The mollic epipedon is 10 to 18 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 through 3. It is dominantly clay loam, but the range includes loam or sandy loam. Reaction ranges from slightly acid to strongly acid. The B2t horizon has value of 3 or 4 (4 or 5, dry), chroma of 3 to 6, and hue of 7.5YR or 5YR. Besides clay loam, the range includes sandy clay loam and gravelly clay loam. Reaction ranges from slightly acid to strongly acid. The C horizon has value of 4 to 6 (5 to 7, dry), chroma of 2 to 6, and hue of 2.5Y to 5YR. The degree of stratification and the texture are variable below a depth of 40 inches. The soil material ranges from compact deposits of clay to gravelly loam or sandy loam. Reaction ranges from medium acid to neutral.

The thickness and darkness of the A horizon and of the upper part of the B horizon of map unit MsC3 are less than that defined as the range for the series. These differences, however, do not affect the use or behavior of the soil.

Nodaway series

The Nodaway series consists of deep, moderately well drained, moderately permeable soils that formed in recent, stratified silty alluvium. These soils are on bottom lands. Slopes range from 0 to 4 percent.

Nodaway soils are in positions next to stream channels. They are adjacent to Colo, Kennebec, and Zook soils. Nodaway soils have better drainage than Colo soils, are more finely stratified than Kennebec soils, and have better drainage and are less clayey than Zook soils.

Typical pedon of Nodaway silt loam, in an area of Nodaway-Colo complex, 0 to 2 percent slopes, 1,150 feet west and 150 feet north of southeast corner of sec. 36, T. 9 N., R. 10 E.

Ap—0 to 6 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak medium and fine blocky structure parting to weak fine granular; friable, slightly hard; neutral; clear smooth boundary.

C—6 to 72 inches; very dark gray (10YR 3/1) and dark grayish brown (10YR 4/2) finely stratified silt loam, gray (10YR 5/1) and grayish brown (10YR 5/2) dry; massive; common fine and medium horizontal planes of cleavage; friable; neutral; clear smooth boundary.

The solum is 4 to 10 inches thick, and so is the A horizon.

The A horizon has color value of 3 (4 or 5, dry) and chroma of 1 or 2. Reaction is neutral or slightly acid. The C horizon has value of 3 to 5 (4 to 6, dry) and chroma of 1 to 3. It is dominantly silt loam, but the fine, individual strata may be silty clay loam or very fine sandy loam. Reaction is neutral or slightly acid. A dark silty clay loam or silt loam buried soil commonly is at a depth of 30 to 70 inches or more.

Onawa series

The Onawa series consists of deep, somewhat poorly drained soils that are slowly permeable in the upper part and moderately permeable in the lower part. These formed in calcareous clayey and silty alluvium. They are on bottom lands. Slopes range from 0 to 1 percent.

Onawa soils are commonly adjacent to Albaton and Haynie soils. Onawa soils are clayey to a depth of about 20 inches, and Albaton soils are clayey to a depth of 40 inches or more. Onawa soils are more clayey than Haynie soils, which are silty throughout.

Typical pedon of Onawa silty clay, 0 to 1 percent slopes, 200 feet south and 80 feet west of northeast corner, sec. 25, T. 8 N., R. 14 E.

Ap—0 to 6 inches; very dark grayish brown (2.5Y 3/2) silty clay, gray (10YR 5/1) dry; weak medium blocky structure parting to moderate very fine angular blocky; firm; slight effervescence; mildly alkaline; clear smooth boundary.

C1—6 to 21 inches; multicolored dark grayish brown (2.5Y 4/2), very dark grayish brown (2.5Y 3/2), and very dark gray (10YR 3/1) silty clay, light brownish gray (2.5Y 6/2), grayish brown (2.5Y 5/2), and dark gray (10YR 4/1) dry; common fine faint dark yellowish brown (10YR 4/4) mottles; massive; common angular planes of cleavage and pressure faces; very firm; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIC2g—21 to 60 inches; grayish brown (2.5Y 5/2) stratified silt loam and very fine sandy loam; common fine distinct dark yellowish brown (10YR 4/4) mottles; massive; some horizontal planes of cleavage; friable; strong effervescence; moderately alkaline.

The solum is 4 to 10 inches thick; its thickness is the same as that of the A horizon. Depth to the loamy IIC horizon ranges from 18 to 30 inches.

The A horizon has color value of 3, chroma of 1 or 2, and hue of 2.5Y or 10YR. It is silty clay or silt loam. The reaction is mildly alkaline or moderately alkaline. The C horizon has value of 3 to 5 (4 to 6, dry) and chroma of 1 or 2. The hue ranges from 5Y to 10YR. The reaction is mildly alkaline or moderately alkaline. The IIC horizon has coloring similar to that of the C horizon. It is coarse silt loam or very fine sandy loam, but individual strata may range from silt loam to fine sandy loam.

Pawnee series

The Pawnee series consists of deep, moderately well drained, slowly permeable soils that formed in loamy, calcareous glacial deposits. Pawnee soils are on ridgetops and side slopes on uplands. Slopes range from 3 to 12 percent.

Pawnee soils are similar to Mayberry soils and are commonly adjacent to Burchard, Mayberry, Shelby, and Wymore soils. They are commonly upslope from Burchard and Shelby soils, are in the same general position on the landscape as Mayberry soils, and in most places are downslope from Wymore soils. Pawnee soils have a more clayey B horizon than Burchard and Shelby soils, and their B horizon is not so red as that of Mayberry soils. Wymore soils formed in loess.

Typical pedon of Pawnee clay loam, 3 to 9 percent slopes, 2,450 feet west and 200 feet north of southeast corner of sec. 4, T. 8 N., R. 9 E.

A1—0 to 8 inches; very dark brown (10YR 2/2) clay loam, dark grayish brown (10YR 4/2) dry; weak medium subangular blocky structure parting to weak very fine granular; friable, hard; slightly acid; clear smooth boundary.

B1—8 to 12 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; weak medium subangular blocky structure parting to moderate fine granular; firm; slightly acid; clear smooth boundary.

B21t—12 to 15 inches; dark brown (10YR 3/3) clay, brown (10YR 5/3) dry; common fine faint brown (7.5YR 4/4) mottles; strong very fine angular blocky structure; very firm; slightly acid; clear smooth boundary.

B22t—15 to 22 inches; brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; many fine distinct reddish brown (5YR 4/4) and few fine faint dark grayish brown (2.5Y 4/2) mottles; moderate medium and fine angular blocky structure; very firm; neutral; few pebbles; gradual smooth boundary.

B23t—22 to 42 inches; brown (10YR 4/3) clay, yellowish brown (10YR 5/4) dry; few fine faint brown (7.5YR 4/4) mottles; moderate medium angular blocky structure; very firm; neutral; gradual smooth boundary.

B3—42 to 56 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/6) dry; few coarse distinct grayish brown (2.5Y 5/2) and strong brown (7.5YR 5/6) mottles; moderate medium and coarse angular blocky structure; firm; few lime concretions; mildly alkaline; gradual smooth boundary.

C—56 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light gray (2.5Y 7/2) dry; few coarse distinct strong brown (7.5YR 5/6) mottles; massive; common angular planes of cleavage; firm; few distinct large dark accumulations as coatings; strong effervescence; mildly alkaline.

The solum is 40 to 60 inches thick. The mollic epipedon is 10 to 18 inches thick. The content of pebbles and cobblestones on the surface and in the profile ranges from less than 1 percent to 15 percent, by volume.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam and clay. In eroded areas, the surface layer is typically clay. Reaction is medium acid or slightly acid. The B2 horizon has value of 3 through 5 (4 through 6, dry) and chroma of 2 through 4. Value generally increases with depth. Reaction ranges from slightly acid to neutral and generally increases abruptly with depth. Except for the high chroma mottles, the C horizon has matrix value of 5 or 6 (6 or 7, dry) and chroma of 2 but includes chroma of 3 in hue of 10YR through 5Y. The C horizon is dominantly clay loam, but it has strata of loam or clay in the till mass. Reaction is mildly or moderately alkaline.

The thickness and darkness of the A horizon and of the upper part of the B horizon of map units PbC2 and PbD2 are less than that defined as the range for the series. These differences, however, do not affect the use or behavior of these soils.

Ponca series

The Ponca series consists of deep, well drained and somewhat excessively drained, moderately permeable soils that formed in loess. These soils are on side slopes on uplands. Slopes range from 5 to 17 percent.

Ponca soils are similar to Marshall and Monona soils and are commonly adjacent to Dow, Marshall, and Monona soils. Ponca soils are in the same general position on the landscape as Dow soils. They are downslope from Marshall and Monona soils. Ponca soils do not have carbonates near the surface, unlike Dow soils. However, carbonates are not leached so deep in Ponca soils as they are in Marshall and Monona soils.

Typical pedon of Ponca silt loam, in an area of Ponca-Dow silt loams, 5 to 11 percent slopes, eroded, 1,530 feet south and 315 feet west of the center of sec. 15, T. 8 N., R. 14 E.

Ap—0 to 8 inches; dark brown (10YR 3/3) silt loam, brown (10YR 4/3) dry; weak medium and fine

subangular blocky structure; friable; neutral; clear wavy boundary.

B2—8 to 18 inches; olive brown (2.5Y 4/4) silt loam, light olive brown (2.5Y 5/4) dry; moderate medium and fine subangular blocky structure; friable; neutral; gradual wavy boundary.

B3—18 to 28 inches; mottled light olive brown (2.5Y 5/4) and olive gray (5Y 5/2) silt loam, light yellowish brown (2.5Y 6/4) and light olive gray (5Y 6/2) dry; weak medium subangular blocky structure; friable; few dark accumulations and iron concretions (pipestems); common small lime concretions; few threads of soft lime; many medium and fine pores; slight effervescence; mildly alkaline; gradual wavy boundary.

C—28 to 60 inches; mottled light olive brown (2.5Y 5/6) and olive gray (5Y 5/2) silt loam, light yellowish brown (2.5Y 6/4) and light gray (5Y 7/2) dry; massive; friable; few dark accumulations and iron concretions (pipestems); common small lime concretions; few threads of soft lime; many fine pores; strong effervescence; mildly alkaline.

The solum thickness and the depth to carbonates range from 12 to 30 inches. The mollic epipedon is 8 to 14 inches thick.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 to 3. It is silty clay loam or silt loam. Reaction is slightly acid or neutral. The B2 horizon has value of 3 to 5 (5 or 6, dry), chroma of 2 to 4, and hue of 10YR and 2.5Y. It is silty clay loam or silt loam. Reaction is neutral or slightly acid. Except for the high chroma mottles, the C horizon has value of 5 or 6 (6 or 7, dry) and chroma of 2 or 3. The dominant hue is 2.5Y, but the range includes 10YR and 5Y. The C horizon is mildly alkaline or moderately alkaline.

The thickness and darkness of the A horizon and of the upper part of the B horizon of map unit PwE2 are less than that defined as the range for the series. These differences, however, do not affect the use or behavior of this soil.

Sarpy series

The Sarpy series consists of deep, excessively drained, rapidly permeable soils. Sarpy soils formed in sandy alluvium on bottom lands. Slopes range from 0 to 3 percent.

Sarpy soils are commonly adjacent to and intermingled with Haynie soils. Sarpy soils are more sandy than Haynie soils, which are silty throughout.

Typical pedon of Sarpy fine sand, in an area of Sarpy-Haynie complex, 0 to 3 percent slopes, 350 feet north and 100 feet east of the southwest corner, sec. 32, T. 8 N., R. 15 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) fine sand, grayish brown (10YR 5/2) dry; single grained; loose; slight effervescence; moderately alkaline; clear smooth boundary.

C—6 to 60 inches; grayish brown (10YR 5/2) fine sand, light brownish gray (10YR 6/2) dry; single grained; loose; slight effervescence; moderately alkaline.

The solum is 4 to 10 inches thick; its thickness corresponds to that of the A horizon.

The A horizon has color value of 3 or 4 (4 or 5, dry) and chroma of 1 through 3. It is dominantly fine sand, but the range includes loamy fine sand and fine sandy loam. Reaction ranges from moderately alkaline to neutral. The C horizon has value of 5 or 6 (6 or 7, dry) and chroma of 2 or 3. The texture is fine sand or loamy fine sand. In some areas, there are thin strata of fine sandy loam or very fine sandy loam in the C horizon. The C horizon is moderately alkaline or mildly alkaline.

Sharpsburg series

The Sharpsburg series consists of deep, moderately well drained soils that have moderately slow permeability. These soils formed in loess and are on uplands. Slopes range from 0 to 11 percent.

Sharpsburg soils are commonly adjacent to Marshall and Wymore soils and other upland soils that formed in loess. Sharpsburg soils have a more clayey B horizon than Marshall soils, and their B horizon is less clayey than that of Wymore soils. Sharpsburg soils are in positions upslope from Pawnee, Mayberry, and Morrill soils, which formed in glacial deposits.

Typical pedon of Sharpsburg silty clay loam, 2 to 5 percent slopes, 2,400 feet south and 200 feet east from northwest corner of sec. 9, T. 9 N., R. 13 E.

Ap—0 to 12 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; weak coarse and medium blocky structure parting to moderate fine granular; friable, hard; slightly acid; clear smooth boundary.

B1—12 to 17 inches; very dark grayish brown (10YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; strong very fine subangular blocky structure; friable; medium acid; clear smooth boundary.

B21t—17 to 27 inches; brown (10YR 4/3) silty clay loam, brown (10YR 5/3) dry; strong fine subangular blocky structure; firm; medium acid; gradual smooth boundary.

B22t—27 to 44 inches; dark yellowish brown (10YR 4/4) silty clay loam, yellowish brown (10YR 5/4) dry; many fine faint grayish brown (10YR 5/2) mottles; moderate medium and fine subangular blocky structure; firm; slightly acid; gradual smooth boundary.

B3—44 to 56 inches; grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/4) mottled silty clay loam, light brownish gray (10YR 6/2) and brownish yellow (10YR 6/6) dry; weak medium angular blocky

structure; friable; slightly acid; gradual smooth boundary.

C—56 to 60 inches; grayish brown (10YR 5/2) and dark yellowish brown (10YR 4/6) mottled silty clay loam, light gray (10YR 7/2) and brownish yellow (10YR 6/6) dry; weak coarse prismatic structure; friable; slightly acid.

The solum is 40 to 60 inches thick. The mollic epipedon is 10 to 20 inches thick.

The A horizon has color value of 2 or 3 (3 or 4, dry) and chroma of 1 to 3. Reaction is medium acid or slightly acid. The Bt horizon ranges from silty clay loam to silty clay, 38 to 42 percent clay. The C horizon has value of 4 to 6 and chroma of 2 to 4. The C horizon is slightly acid or neutral.

The A horizon and the upper part of the B horizon of map units ShC2 and ShD2 are lighter in color than is defined as the range for the series. This difference, however, does not affect the use or behavior of these soils.

Shelby series

The Shelby series consists of deep, well drained to excessively drained soils that have moderately slow permeability. These soils formed in fine-loamy, calcareous glacial deposits. They are on side slopes on uplands. Slopes range from 9 to 70 percent.

Shelby soils are similar to Burchard soils and are commonly adjacent to Burchard, Pawnee, and Steinauer soils. They are in the same general position on the landscape as the Burchard and Steinauer soils but in most places are downslope from the Pawnee soils. Carbonates are leached deeper in Shelby soils than in Burchard soils. Shelby soils have a mollic epipedon and do not have carbonates near the surface, unlike Steinauer soils. Shelby soils have a less clayey B horizon than the Pawnee soils.

Typical pedon of Shelby clay loam, in an area of Shelby and Burchard clay loams, 9 to 15 percent slopes, 1,520 feet west and 100 feet south from northeast corner of sec. 27, T. 9 N., R. 10 E.

A1—0 to 10 inches; black (10YR 2/1) clay loam, dark gray (10YR 4/1) dry; moderate fine subangular blocky structure parting to weak fine granular; hard, friable; medium acid; gradual smooth boundary.

B1—10 to 16 inches; very dark grayish brown (10YR 3/2) clay loam, grayish brown (10YR 5/2) dry; moderate fine subangular blocky structure; friable; medium acid; gradual smooth boundary.

B21t—16 to 28 inches; brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate fine and very fine subangular blocky structure; firm; thin patchy clay films; slightly acid; gradual smooth boundary.

B22t—28 to 36 inches; brown (10YR 4/3) clay loam, yellowish brown (10YR 5/4) dry; moderate medium subangular blocky structure; firm; thin patchy clay films; slightly acid; gradual smooth boundary.

B3t—36 to 42 inches; dark yellowish brown (10YR 4/4) clay loam, yellowish brown (10YR 5/4) dry; few fine faint brown (7.5YR 4/4) relict mottles; weak medium angular blocky structure; firm; thin patchy clay films; neutral; gradual smooth boundary.

C—42 to 60 inches; mottled grayish brown (2.5Y 5/2) and brown (7.5YR 5/4) clay loam, light brownish gray (2.5Y 6/2) and light brown (7.5YR 6/4) dry; massive; horizontal and vertical planes of cleavage; firm; few thin patchy clay films; few thin strata of sandy loam; neutral.

The solum is about 30 to 60 inches thick. The mollic epipedon is 10 to 24 inches thick. The depth to free carbonates is greater than 30 inches. The content of pebbles and cobblestones on the surface and in the profile ranges from 1 to 15 percent, by volume.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 1 or 2. It is dominantly clay loam, but the range includes loam. Reaction is medium acid or slightly acid. The B2t horizon has value of 3 to 5 (4 to 6, dry) and chroma of 3 but the range is 3 to 6. The B2t horizon ranges from medium acid to neutral. The C horizon is clay loam or loam. It ranges from neutral to moderately alkaline.

Steinauer series

The Steinauer series consists of deep, somewhat excessively drained soils that have moderately slow permeability. These soils formed in loamy, calcareous glacial deposits. They are on side slopes on uplands. Slopes range from 11 to 20 percent.

Steinauer soils are commonly adjacent to Burchard, Pawnee, and Shelby soils. They are in the same general position on the landscape as the Burchard and Shelby soils but are most often in places downslope from the Pawnee soils. Steinauer soils do not have a mollic epipedon and have not been leached of free carbonates, unlike the associated soils. In addition, Steinauer soils have less clay in the solum than the Pawnee soils.

Typical pedon of Steinauer clay loam, 11 to 20 percent slopes, 1,200 feet north and 420 feet east of the southwest corner of sec. 22, T. 8 N., R. 9 E.

A1—0 to 5 inches; very dark grayish brown (2.5Y 3/2) clay loam, dark gray (10YR 4/1) dry; weak medium and fine granular structure; friable, hard; 8 to 10 percent, by volume, gravel size pebbles (less than 3 inches in size); violent effervescence; mildly alkaline; gradual smooth boundary.

AC1—5 to 9 inches; dark grayish brown (10YR 4/2) clay loam, grayish brown (10YR 5/2) dry; moderate very fine subangular blocky structure; friable; violent

effervescence; moderately alkaline; gradual smooth boundary.

AC2—9 to 18 inches; yellowish brown (10YR 5/4) clay loam, light yellowish brown (10YR 6/4) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; moderate fine and very fine subangular blocky structure; friable; violent effervescence; moderately alkaline; gradual wavy boundary.

C—18 to 60 inches; grayish brown (2.5Y 5/2) clay loam, light brownish gray (10YR 6/2) dry; many coarse prominent dark yellowish brown (10YR 4/4) and yellowish brown (10YR 5/6) mottles; massive; common angular planes of cleavage; firm; common medium lime and iron concretions; common seams of soft white lime; few dark accumulations (oxides) on cleavage planes; violent effervescence; moderately alkaline.

The solum is 10 to 21 inches thick. The depth to free carbonates ranges from 0 to about 10 inches. The content of pebbles and cobblestones on the surface and in the profile ranges from 2 to 20 percent, by volume.

The A horizon has color value of 3 through 5 (5 or 6, dry) and chroma of 1 or 2. It is dominantly clay loam, but it ranges from loam to gravelly clay loam. Reaction is mildly alkaline or moderately alkaline. The AC horizon has value of 4 or 5 (5 or 6, dry) and chroma of 1 through 4. The C horizon is dominantly clay loam, but the range includes loam. Some pedons have thin strata or pockets of sandy material and a stratified C horizon.

Wabash series

The Wabash series consists of deep, very poorly drained soils that have very slow permeability. These soils formed in clayey alluvium on bottom lands. Slopes range from 0 to 1 percent.

Wabash soils are commonly adjacent to the Zook and Zoe soils. They are in the same general position on the landscape as these associated soils, most often on the lower bottom lands. Wabash soils are more clayey in the upper part of the profile than the Zook soils. They have less soluble salts and exchangeable sodium than the Zoe soils.

Typical pedon of Wabash silty clay, 0 to 1 percent slopes, 930 feet east and 75 feet south of the northwest corner of sec. 13, T. 7 N., R. 11 E.

Ap—0 to 10 inches; black (10YR 2/1) silty clay, very dark gray (10YR 3/1) dry; moderate medium and fine angular blocky structure; very firm, very hard; shiny faces on peds; slightly acid; clear smooth boundary.

A12—10 to 34 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium and fine angular blocky structure; very firm; shiny faces on peds; common fine round dark concretions (oxides); medium acid; gradual smooth boundary.

A13—34 to 45 inches; black (N 2/0) silty clay, dark gray (N 4/0) dry; moderate medium and fine angular blocky structure; very firm; shiny faces on peds; common fine round dark concretions (oxides); slightly acid; gradual smooth boundary.

B2g—45 to 56 inches; very dark gray (5Y 3/1) silty clay, gray (5Y 5/1) dry; weak medium angular blocky structure; very firm; shiny faces on peds; common fine round dark concretions (oxides); neutral; gradual smooth boundary.

Cg—56 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few medium distinct dark yellowish brown (10YR 4/4) mottles; massive; firm; few fine round dark concretions (oxides); few prominent small lime concretions in upper part that have strong effervescence; mildly alkaline.

The thickness of the solum and the depth to free carbonates range from 40 to 60 inches or more.

The A horizon has color value of 2 or 3 (3 or 4, dry) and chroma of 0 or 1 in hue of 10YR through 5Y. Reaction is medium acid or slightly acid. Some pedons have a thin Ap horizon of silty clay loam. The C horizon has value of 4 or 5 (5 or 6, dry) and chroma of 0 through 2 in hue of 10YR through 5Y. The C horizon ranges from slightly acid to mildly alkaline.

Wymore series

The Wymore series consists of deep, moderately well drained, slowly permeable soils that formed in loess. Wymore soils are on uplands. Slopes range from 0 to 7 percent.

Wymore soils are commonly adjacent to the Sharpsburg and Pawnee soils. Wymore soils have a more clayey B horizon than the Sharpsburg soils. They are upslope from the Pawnee soils, which formed in glacial deposits.

Typical pedon of Wymore silty clay loam, 0 to 2 percent slopes, 1,835 feet south and 500 feet west from the northeast corner of sec. 19, T. 8 N., R. 11 E.

Ap—0 to 10 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak coarse and medium angular blocky structure parting to weak fine subangular blocky; friable, hard; medium acid; abrupt smooth boundary.

B21t—10 to 15 inches; very dark grayish brown (10YR 3/2) silty clay, grayish brown (10YR 5/2) dry; strong fine and very fine subangular blocky structure; firm; medium acid; clear smooth boundary.

B22t—15 to 27 inches; dark grayish brown (10YR 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; few fine faint dark yellowish brown (10YR 4/4) mottles; strong medium and fine angular blocky structure; firm; common organic coatings on sides or faces of peds; slightly acid; gradual smooth boundary.

B23t—27 to 40 inches; olive brown (2.5Y 4/4) silty clay, light yellowish brown (2.5Y 6/4) dry; common fine faint dark yellowish brown (10YR 4/4) and common medium distinct grayish brown (2.5Y 5/2) mottles; moderate medium angular blocky structure; firm; slightly acid; gradual smooth boundary.

B3—40 to 52 inches; grayish brown (2.5Y 5/2) and dark yellowish brown (10YR 4/4) mottled silty clay loam, light gray (2.5Y 7/2) and light yellowish brown (10YR 6/4) dry; weak coarse and medium angular blocky structure; friable; few distinct accumulations of black oxide; neutral; gradual smooth boundary.

C—52 to 60 inches; grayish brown (2.5Y 5/2), olive gray (5Y 5/2), and dark yellowish brown (10YR 4/4), mottled silty clay loam, light gray (2.5Y 7/2) and light yellowish brown (10YR 6/4) dry; massive; some vertical planes of cleavage; friable; common distinct accumulations of black oxide; neutral.

The solum is 25 to 52 inches thick. The mollic epipedon is 10 to 18 inches thick. The position of the soil on the landscape, slope, and erosion affect the thickness and texture of the A horizon, the depth to the layer that is highest in content of clay, the thickness of the B horizon, the depth to mottles, and the thickness of the solum.

The A horizon has color value of 2 or 3 (3 or 4, dry) and chroma of 1 or 2. Reaction is medium acid or slightly acid. The B2t horizon has dominant value of 3 or 4 (5 or 6, dry) and dominant chroma of 2, but in some pedons value is 2 in the upper part, and chroma is 3 or 4 in the lower part. The lower part of the B2t horizon ranges from strongly to weakly mottled; the mottles range in color from grayish brown to olive brown. The C horizon is slightly acid or neutral.

The thickness and darkness of the A horizon and of the upper part of the B horizon of map unit WtC2 are less than that defined as the range for the series. These differences, however, do not affect the use or behavior of the soil.

Zoe series

The Zoe series consists of deep, poorly drained, saline-alkaline soils that have very slow permeability. These soils formed in alluvium and are on bottom lands. Slopes range from 0 to 1 percent.

Zoe soils are commonly adjacent to the Wabash and Zook soils. They are in the same general position on the landscape as the associated soils. Zoe soils have more soluble salts and exchangeable sodium than the Wabash and Zook soils.

Typical pedon of Zoe silty clay loam, 0 to 1 percent slopes, 1,080 feet south and 830 feet west of the northeast corner of sec. 24, T. 7 N., R. 11 E.

Ap—0 to 8 inches; very dark gray (10YR 3/1) silty clay loam, gray (10YR 5/1) dry; weak medium angular blocky structure; firm, hard; neutral; abrupt wavy boundary.

A12—8 to 11 inches; black (10YR 2/1) silty clay loam, gray (10YR 5/1) dry; weak coarse blocky structure parting to moderate medium and fine angular blocky; firm, hard; neutral; abrupt smooth boundary.

A13—11 to 16 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse platy structure parting to moderate fine angular blocky; firm, hard; common uncoated or clean silt and sand grains on ped faces; neutral; clear smooth boundary.

A14—16 to 24 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak coarse platy structure parting to moderate fine angular blocky; firm, hard; common light colored threads of medium distinct salt accumulations on ped faces; slight effervescence; mildly alkaline; abrupt smooth boundary.

A15—24 to 36 inches; very dark grayish brown (2.5Y 3/2) silty clay, grayish brown (2.5Y 5/2) dry; common medium faint dark grayish (2.5Y 4/2) and distinct yellowish brown (10YR 5/6) mottles; weak coarse prismatic structure; very firm, very hard; common fine dark concretions of iron manganese and common medium concretions of calcium carbonate; mildly alkaline; gradual smooth boundary.

C—36 to 60 inches; dark grayish brown (2.5Y 4/2) silty clay, light brownish gray (2.5Y 6/2) dry; many medium faint very dark grayish brown (2.5Y 3/2) and olive brown (2.5Y 4/4) mottles; massive; very firm, very hard; common fine dark concretions of iron manganese and common medium and coarse calcium carbonate concretions; strong effervescence in calcium carbonate concretions only; mildly alkaline.

The solum and mollic epipedon are 26 to 40 inches thick. Depth to lime ranges from 11 to 23 inches. Conductivity of the saturation extract ranges from 1 to 3 millimhos per centimeter at a depth of less than 12 inches and 4 to 8 millimhos at a depth of more than 12 inches.

The A horizon has color value of 2 or 3 (4 or 5, dry) and chroma of 0 through 2. The Ap horizon is dominantly silty clay loam, but the range includes loam. The A horizon ranges from slightly acid to mildly alkaline. The C horizon has color value of 2 through 4 (5 or 6, dry) and chroma of 1 or 2. The C horizon ranges from mildly alkaline to strongly alkaline.

Zook series

The Zook series consists of deep, poorly drained, slowly permeable soils that formed in silty and clayey alluvium. These soils are on bottom lands. Slopes range from 0 to 1 percent.

Zook soils are in low positions on broad bottom lands some distance from stream channels. They are

commonly adjacent to Wabash and Zoe soils, which are in similar positions on the landscape. Also, Zook soils are commonly adjacent to Colo, Kennebec, and Nodaway soils, which are in positions adjacent to stream channels. Zook soils have less clay in the upper part of the profile than Wabash soils and have less soluble and alkaline salts than the Zoe soils. Zook soils are more clayey than the Colo, Kennebec, and Nodaway soils and are more poorly drained than the Kennebec and Nodaway soils.

Typical pedon of Zook silty clay loam, 0 to 1 percent slopes, 2,740 feet north and 150 feet west of the southeast corner of sec. 22, T. 7 N., R. 12 E.

Ap—0 to 10 inches; very dark brown (10YR 2/2) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine angular blocky structure; friable, hard; slightly acid; abrupt smooth boundary.

A12—10 to 25 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak medium and fine angular blocky structure parting to weak fine granular; friable; slightly acid; gradual smooth boundary.

A13—25 to 44 inches; black (10YR 2/1) silty clay, dark gray (10YR 4/1) dry; moderate medium angular blocky structure; firm; shiny faces on peds; slightly acid; gradual smooth boundary.

B2g—44 to 66 inches; very dark gray (10YR 3/1) silty clay, dark gray (10YR 4/1) crushed, gray (10YR 5/1) dry; weak medium and coarse angular blocky structure; firm; shiny faces on peds; few fine dark concretions (oxides); few medium lime concretions; neutral; gradual smooth boundary.

Cg—66 to 80 inches; dark gray (10YR 4/1) silty clay, gray (10YR 5/1) dry; massive; few fine dark concretions (oxides); few medium lime concretions; neutral.

The solum is 36 to 70 inches thick. The mollic epipedon is 30 to 50 inches thick.

The A horizon has color value of 2 or 3 (3 or 4, dry) and chroma of 0 through 2 in hue of 10YR or 2.5Y and neutral. The silty clay loam in the upper part of the profile is 12 to 25 inches thick. In some places, there is an Ap horizon that is silt loam. The A horizon is commonly slightly acid but ranges from medium acid to neutral. The B and C horizons have value of 3 to 5 (4 to 6, dry) and chroma of 1 or 2 in hue of 10YR through 5Y. Reaction ranges from slightly acid to mildly alkaline. Some pedons have mottles of high value and chroma at a depth of 36 inches or more.

formation of the soils

Soil is produced through the interaction of five major soil forming factors—parent material, time, relief, plants and animals, and climate. The kind of soil that forms in any place on the earth is determined by the interaction of these factors.

Climate and plants and animals are the active factors of soil formation. They act on the parent material, which has accumulated through the weathering of rock and unconsolidated deposits, and slowly change it to a natural body that has genetically related horizons. The effects of climate and of plants and animals are conditioned by relief.

Parent material also influences soil formation and, in extreme cases, entirely determines the kind of soil that is formed. Finally, time is needed to change the parent material into soil. In general, a long time is required for distinct horizons to develop in a soil.

The interrelationship among the five factors of soil formation is complex, and the effect of any one factor is difficult to isolate. Each factor is discussed separately in the following paragraphs; however, it is the interaction among all five factors, rather than just their simple sum, that determines the nature of the soil.

parent material

Parent material is the unconsolidated mass in which a soil forms. It determines the chemical and mineralogical composition of the soil. The soils in Otoe County formed in recent alluvium, loess, water-deposited clay, silt, sand and gravel, glacial material, and residuum of weathered shale and limestone. Alluvium is the youngest material, and the Pennsylvanian limestone and shale are the oldest.

Geologic erosion has stripped most of the ancient soils from the landscape and exposed fresh parent material. As a result, the soils forming in parent material that is a million years old have been forming for about the same length of time as the soils forming in the most recent loess, which is less than 20,000 years old.

The oldest geologic materials in which modern soils have formed are Permian and Pennsylvanian limestone and shale. These materials were deposited in shallow seas 200 to 300 million years ago. They were buried under many feet of younger deposits but have been reexposed in small areas on slopes bordering the valleys of the Little Nemaha and Missouri Rivers. They consist of ledges of moderately hard limestone and beds of calcareous silty shale. These materials weather to olive gray, olive, pale yellow, and brown silty material that has shale and limestone fragments. Benfield and Kipson soils formed in this material.

Material left by the Nebraskan glacier overlies the shale and limestone. It is clayey till containing many limestone pebbles, cobbles, and a small amount of quartzitic sand and stone. The acreage of soils that formed in this material is small. Most of this material has been deeply covered by recent sediment, and only outcrops remain.

During the Fullerton age, after the retreat of the Nebraskan glacier, alluvial silt and fine sand were deposited. These buried deposits are preserved mainly in upland areas in the southern part of the county and are exposed on rolling hillsides. Malcolm soils formed in the grayish silt and very fine sand, and Dickinson soils formed in the fine sand. In places, remnants of ancient Afton soil, which formed in Fullerton material, can be identified by the clay texture and dark color. Such outcrops are thinly vegetated areas.

Kansan glacial material was the next deposit laid down in the county. Much of this material has been removed by geologic erosion, and, in places, all of it has been washed and older materials are exposed. In places, more recent material covers the glacial deposits, but on slopes that border stream valleys and over a large area in the western part of Otoe County, the glacial material is at the surface. This material is a mixture of clay, sand, and silt and numerous pebbles, few granite or quartzite boulders, and common cobbles. Thin layers and isolated pockets of sandy material or sand and gravel are in the till. Outcrops of this coarse material are shown on the soil maps by a spot symbol. The unoxidized and unweathered till is gray, but the till exposed in roadcuts and in the lower part of the soils is oxidized and weathered to grayish brown and has yellowish brown, strong brown, and dark brown iron stains and iron concretions. Cracks and seams are filled with soft, white lime. Burchard, Pawnee, Shelby, and Steinauer soils formed in this till. These soils differ chiefly in the amount of clay in the subsoil and in the depth to which lime has been leached.

The ancient soil that developed in the till, Yarmouth soil, does not show up in outcrops or in test borings. Soils that formed in the Kansan till were probably removed by erosion at the end of the Kansan age. The

silt and clay were washed from the area, and the coarser gravel, stones, and boulders were left. It was on this surface that the Illinoian material was deposited.

Illinoian material was deposited throughout the county, but the tracts of soil that formed in this material are small. The material, which lies below Peoria loess and above glacial material, is exposed only on slopes. The reddish brown Illinoian soils contrast sharply with the yellowish brown and grayish brown soils that formed in Peoria loess and in Kansan glacial material.

Mayberry soils formed in clayey sediment that contains sand, pebbles, and stones derived from glacial material. Morrill soils formed in loamy sediment that contains many sand grains and a few pebbles. Loveland loess, which is late Illinoian, is thin and not extensive as parent material, and the small areas of soil that formed in this material are included with the Mayberry and Morrill soils.

Peoria loess is the most recently deposited parent material. It is yellowish brown to light olive gray silt loam or silty clay loam that was carried by wind. It was deposited throughout the area and now remains where geologic erosion has been least active. These areas are the divides, ridges, and slopes on the higher elevations throughout the county. Peoria loess is the most extensive parent material in the county. Dow, Marshall, Monona, Ponca, Sharpsburg, and the large areas of Wymore soils formed in this loess. These soils differ chiefly in the amount of clay in the subsoil and in the depth to which lime has been leached.

The recent alluvium consists of grayish brown to black clayey to sandy sediment that washed from upland slopes onto the flood plains and valleys. Albaton, Colo, Haynie, Kennebec, Nodaway, Onawa, Sarpy, Wabash, Zoe, and Zook soils formed in this alluvial material. Some of these low plains and valleys are flooded, and fresh deposits continue to accumulate on the soils.

climate

Climate affects weathering and soil formation in several ways. The kind and amount of rainfall received, temperature, humidity, and the nature of the winds are climatic factors. Climate also affects soil formation through its influence on the type and variety of plant and animal life. In Otoe County, the climate is fairly uniform, and local differences in soils cannot be attributed to differences in climate.

During the last geologic period, many climatic cycles influenced the shaping of the landscape and the deposition of parent material in Otoe County. Cold, wet periods activated glaciers that deposited glacial material. Dry, windy periods produced dust that accumulated as deposits of loess. Interspaced were stable periods of weathering and soil formation and periods of dissection and erosion.

Since deposition, the parent materials in Otoe County have undergone marked changes in color, structure, and composition. These changes are usually caused by leaching, oxidation, and other weathering processes; the accumulation of organic matter; the concentration of colloids and clay in the subsoil; and the partial removal of lime from the surface layer and upper part of the subsoil.

The parent materials originally varied in their content of free calcium carbonate. Leaching has removed most of the carbonates, as well as other soluble constituents, to a depth below the subsoil. Now, except for a few eroded soils and areas of recent alluvium, most of the soils are medium to slightly acid in the surface layer and upper part of the subsoil. The soils do, however, contain a high percentage of the basic elements of a fertile soil.

An example of the influence of climate on the present character of the soils in Otoe County is the uniform chemical composition of soils that formed on similar terrain but in different parent material. This uniformity has been brought about by a moderately long period of weathering.

plants and animals

Plants and animals have had a pronounced effect on soil formation in Otoe County. Vegetation, which is determined by climate, is one of the most important factors in soil formation. Animals are important in the way they use and convert vegetation. Human activity has an important effect on the formation of soil; some soil properties have changed because of man's use of the soil.

One of the most striking characteristics of the uneroded grassland soils in Otoe County is the dark color, which is a result of large amounts of organic matter in the soils. Prior to settlement, bluestem prairies dominated the landscape. The stems, leaves, and roots of the tall grasses were an abundant supply of organic material. As a result, a thick, granular, dark colored soil formed at the surface.

There is evidence of forest influence on soil formation in some small wooded areas in the eastern part of Otoe County. The soils there have a silty 8-inch surface layer that has some grayish color in the lower part, and they have an abrupt boundary to a brownish, more clayey, argillic B horizon. These distinguishing properties are not present in soils on adjoining farm areas, probably because of cultivation and erosion.

Grassland plants extract calcium and other minerals from the soil and parent material and return them to the surface through the decay of the stems and leaves. This process and the fibrous root systems of grassland plants favor the formation of soil structure and the movement of water and soil particles in the soil. Other processes involve chemical and physical action. The decay of organic materials and other compounds produces acids in the mineral part of the soil. Physical action includes

the shrinking and swelling of fine particles as the soil is alternately dry and moist.

Some organic matter is lost through oxidation when the soil is plowed because mixing the soil speeds the decay of organic material. On slopes not protected from rain, much of the original surface soil, and the organic matter, has been lost through erosion. Cultivated soils never regain their original high content of organic matter because of the high oxidation rate under present farming methods. If erosion is controlled, the content of organic matter remains at a moderate level if crop residue from corn, sorghum, and small grains are returned to the soil.

Micro-organisms, ants, earthworms, and burrowing rodents have a beneficial effect on the fertility, structure, and productivity of the soil. Micro-organisms convert nitrogen, phosphorus, and potassium into a form available to plants. Many minor elements or trace minerals, for example, zinc, sulphur, magnesium, and calcium, are made available to plants by specific kinds of micro-organisms. Earthworms and small burrowing animals influence the formation of soil by mixing organic matter with mineral soil material. Their burrowing activities keep soils aerated and bring unleached parent material to the surface.

The activity of man affects the formation of soil. Some of the effects are accelerated sheet and gully erosion, changes of the moisture regime through runoff and improved drainage, and the addition of plant nutrients and other soil amendments. In places, erosion has changed the texture of the surface layer. Also, in places, man has drastically changed the kinds of living organisms in the soil. The results of these changes may not be evident for centuries. Man can directly change the soil by disturbing it, by adding chemicals, or by doing other things to make it suitable for his use.

relief

Some differences among soils can be attributed to local variations in relief. Relief affects soil formation mainly through its effect on drainage and runoff. In this way, relief modifies the effects of climate. Runoff is more rapid in steep areas than in nearly level or gently sloping areas. Consequently, less water soaks into the soil in steep areas, and there is less leaching. Also, loss of soil through erosion is greater in steep areas. Soil horizons in these areas are not distinct, and the solum is thin.

The differences in soil properties between Steinauer, Burchard, and Pawnee soils can be attributed to relief. These soils have the same parent material. Steinauer soils are on steep slopes; they are weakly developed, have a thin surface layer, and have lime at the surface. Burchard soils, which are commonly not so steep, have a surface layer that is thicker and more acid than that of Steinauer soils. Furthermore, lime is leached to a greater depth, and a thin subsoil has formed. Pawnee soils are gently sloping to strongly sloping. They are in the more stable positions in drainage basins. Their subsoil is well developed, and lime is leached to a greater depth than in Burchard or Steinauer soils.

Relief and the position of the soil in relation to the water table and runoff water are also important. The water table and runoff increase the moisture in a soil. Moisture, in turn, affects the kind and amount of vegetation that can grow on the soil. The water table and runoff are the most likely sources of salts and alkali that form alkaline spots and influence the formation of some soils, for example, Zoe soils.

time

The properties of a soil commonly reflect the time a soil has been affected by the soil forming processes. If the parent material has been in place only a short time, climate and plants and animals have not had long to act, and the soils lack well-defined horizons. Haynie and Sarpy soils are examples. These soils formed in recent alluvium, some of which was deposited during the last few years, and lack well-defined horizons.

The time required for soil formation depends on the parent material and the climate. For example, leaching is rapid in sandy material and slow in fine textured clayey material. Sandy material contains few weatherable minerals, and chemical and physical activity is weak. Fine textured clayey material, on the other hand, is rich in weatherable minerals, and chemical and physical activity is strong. Generally, a parent material that is medium in texture is optimal for soil formation. Water moves through the material at a moderate rate, and there are weatherable minerals for chemical and physical activity. Some scientists believe that clays form in place, especially in fine textured material, and that leaching is not necessary for an increase of clay in the soil.

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glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Association, soil. A group of soils geographically associated in a characteristic repeating pattern and defined and delineated as a single map unit.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Bottom land. The normal flood plain of a stream, subject to flooding.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Channery soil. A soil that is, by volume, more than 15 percent thin, flat fragments of sandstone, shale, slate, limestone, or schist as much as 6 inches along the longest axis. A single piece is called a fragment.

Chiseling. Tillage with an implement having one or more soil-penetrating points that loosen the subsoil and bring clods to the surface. A form of emergency tillage to control soil blowing.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Coarse fragments. If round, mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter; if flat, mineral or rock particles (flagstone) 15.2 to 38.1 centimeters (6 to 15 inches) long.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Colluvium. Soil material, rock fragments, or both moved by creep, slide, or local wash and deposited at the base of steep slopes.

Complex, soil. A map unit of two or more kinds of soil in such an intricate pattern or so small in area that it is not practical to map them separately at the selected scale of mapping. The pattern and proportion of the soils are somewhat similar in all areas.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system which creates the best possible environment for growing a crop with a limited amount of soil disturbance and maximum retention of crop residue on the surface.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.
Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.
Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.
Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.
Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.
Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.
Soft.—When dry, breaks into powder or individual grains under very slight pressure.
Cemented.—Hard; little affected by moistening.

Contour stripcropping. Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth, soil. The total thickness of weathered soil material over bedrock. In this survey the classes of soil depth are very shallow, 0 to 10 inches; shallow, 10 to 20 inches; moderately deep, 20 to 40 inches; and deep, more than 40 inches.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:
Excessively drained.—Water is removed from the soil very rapidly. Excessively drained soils are commonly very coarse textured, rocky, or shallow. Some are steep. All are free of the mottling related to wetness.
Somewhat excessively drained.—Water is removed from the soil rapidly. Many somewhat excessively drained soils are sandy and rapidly pervious. Some are shallow. Some are so steep that much of the water they receive is lost as runoff. All are free of the mottling related to wetness.
Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.
Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically they are wet long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.
Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.
Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.
Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly continuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the

activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Excess alkali (in tables). Excess exchangeable sodium in the soil. The resulting poor physical properties restrict the growth of plants.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flagstone. A thin fragment of sandstone, limestone, slate, shale, or (rarely) schist, 6 to 15 inches (15 to 37.5 centimeters) long.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Forb. Any herbaceous plant not a grass or a sedge.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Genesis, soil. The mode of origin of the soil. Refers especially to the processes or soil-forming factors responsible for the formation of the solum, or true soil, from the unconsolidated parent material.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:

O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.

A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow

over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Irrigation. Application of water to soils to assist in production of crops. Methods of irrigation are—
Border.—Water is applied at the upper end of a strip in which the lateral flow of water is controlled by small earth ridges called border dikes, or borders.
Basin.—Water is applied rapidly to nearly level plains surrounded by levees or dikes.
Controlled flooding.—Water is released at intervals from closely spaced field ditches and distributed uniformly over the field.
Corrugation.—Water is applied to small, closely spaced furrows or ditches in fields of close-growing crops or in orchards so that it flows in only one direction.
Drip (or trickle).—Water is applied slowly and under low pressure to the surface of the soil or into the soil through such applicators as emitters, porous tubing, or perforated pipe.
Furrow.—Water is applied in small ditches made by cultivation implements. Furrows are used for tree and row crops.
Sprinkler.—Water is sprayed over the soil surface through pipes or nozzles from a pressure system.
Subirrigation.—Water is applied in open ditches or tile lines until the water table is raised enough to wet the soil.
Wild flooding.—Water, released at high points, is allowed to flow onto an area without controlled distribution.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Moderately coarse textured soil. Sandy loam and fine sandy loam.

Moderately fine textured soil. Clay loam, sandy clay loam, and silty clay loam.

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Organic-matter content. The amount of organic matter in soil material. The classes used in this survey are low, 0.5 to 1.0 percent organic matter present; moderately low, 1.0 to 2.0 percent; moderate, 2.0 to 4.0 percent; and high, 4.0 to 8.0 percent.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability

is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Plowpan. A compacted layer formed in the soil directly below the plowed layer.

Ponding. Standing water on soils in closed depressions. The water can be removed only by percolation or evapotranspiration.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Proper grazing use. The removal of not more than 50 percent by weight of the key management plants.

Rangeland. Land on which the potential natural vegetation is predominantly grasses, grasslike plants, forbs, or shrubs suitable for grazing or browsing. It includes natural grasslands, savannas, many wetlands, some deserts, tundras, and areas that support certain forb and shrub communities.

Range condition. The present composition of the plant community on a range site in relation to the potential natural plant community for that site. Range condition is expressed as excellent, good, fair, or poor, on the basis of how much the present plant community has departed from the potential.

Range site. An area of rangeland where climate, soil, and relief are sufficiently uniform to produce a distinct natural plant community. A range site is the product of all the environmental factors responsible for its development. It is typified by an association of species that differ from those on other range sites in kind or proportion of species or total production.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rill. A steep sided channel resulting from accelerated erosion. A rill is generally a few inches deep and not wide enough to be an obstacle to farm machinery.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Rock fragments. Rock or mineral fragments having a diameter of 2 millimeters or more; for example, pebbles, cobbles, stones, and boulders.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shale. Sedimentary rock formed by the hardening of a clay deposit.

Sheet erosion. The removal of a fairly uniform layer of soil material from the land surface by the action of rainfall and runoff water.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance. In this survey, the classes of slope are:

Nearly level	0 to 2 percent
Very gently sloping	1 to 3 percent
Gently sloping	2 to 6 percent
Strongly sloping	6 to 11 percent
Moderately steep	11 to 17 percent
Steep	15 to 30 percent
Very steep	more than 30 percent

Slow intake (in tables). The slow movement of water into the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Any surface soil horizon (A1, A2, or A3) below the surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Surface, soil. The A horizon. Includes all subdivisions of this horizon (A1, A2, and A3).

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that water soaks into the soil or flows slowly to a prepared outlet. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt loam, silt, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Unstable fill (in tables). Risk of caving or sloughing on banks of fill material.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the lowlands along streams.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

tables

TABLE 1.--TEMPERATURE AND PRECIPITATION

[Recorded in the period 1951-73 at Syracuse, Nebraska]

Month	Temperature						Precipitation				
	Average daily maximum	Average daily minimum	Average daily	2 years in 10 will have-- Maximum temperature higher than--	2 years in 10 will have-- Minimum temperature lower than--	Average number of growing degree days[1]	Average	2 years in 10 will have-- Less than--	2 years in 10 will have-- More than--	Average number of days with 0.10 inch or more	Average snowfall
	°F	°F	°F	°F	°F	Units	In	In	In		In
January----	32.8	10.9	21.9	60	-15	0	.71	.24	1.08	3	6.1
February---	39.7	17.2	28.5	70	-11	10	1.00	.34	1.52	3	5.4
March------	49.3	26.0	37.7	84	-2	49	1.99	.59	3.10	4	5.7
April------	65.0	39.2	52.1	89	19	124	2.64	1.42	3.62	5	.5
May--------	75.9	50.8	63.4	95	30	420	3.90	2.23	5.26	7	.1
June-------	85.3	60.8	73.1	101	43	693	4.90	2.17	7.11	7	.0
July-------	89.7	64.9	77.3	103	48	846	3.94	1.81	5.67	6	.0
August-----	88.3	63.0	75.7	104	47	797	4.40	1.75	6.53	6	.0
September--	79.3	53.4	66.4	99	31	492	3.64	1.48	5.37	5	.0
October----	68.9	41.8	55.4	91	21	215	2.46	.45	4.02	4	.0
November---	51.5	27.8	39.7	76	4	12	1.24	.29	1.99	3	2.3
December---	38.3	17.2	27.7	65	-12	0	.88	.29	1.34	2	4.9
Yearly:											
Average--	63.7	39.4	51.6	---	---	---	---	---	---	---	---
Extreme--	---	---	---	105	-17	---	---	---	---	---	---
Total----	---	---	---	---	---	3,658	31.70	25.20	37.83	55	25.0

[1]A growing degree day is a unit of heat available for plant growth. It can be calculated by adding the maximum and minimum daily temperatures, dividing the sum by 2, and subtracting the temperature below which growth is minimal for the principal crops in the area (50° F).

TABLE 2.--FREEZE DATES IN SPRING AND FALL

[Recorded in the period 1951-73 at Syracuse, Nebraska]

Probability	Temperature		
	24° F or lower	28° F or lower	32° F or lower
Last freezing temperature in spring:			
1 year in 10 later than--	April 20	April 27	May 13
2 years in 10 later than--	April 15	April 23	May 8
5 years in 10 later than--	April 6	April 15	April 28
First freezing temperature in fall:			
1 year in 10 earlier than--	October 17	October 5	September 21
2 years in 10 earlier than--	October 22	October 10	September 26
5 years in 10 earlier than--	October 31	October 18	October 6

TABLE 3.--GROWING SEASON

[Recorded in the period 1951-73 at Syracuse, Nebraska]

Probability	Length of growing season if daily minimum temperature is--		
	Higher than 24° F	Higher than 28° F	Higher than 32° F
	Days	Days	Days
9 years in 10	187	167	138
8 years in 10	194	173	146
5 years in 10	208	185	160
2 years in 10	221	197	175
1 year in 10	229	204	182

TABLE 4.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ab	Albaton silty clay, 0 to 1 percent slopes	1,730	0.4
Co	Colo silty clay loam, 0 to 1 percent slopes	1,430	0.4
DcD	Dickinson fine sandy loam, 6 to 11 percent slopes	520	0.1
DcF	Dickinson fine sandy loam, 11 to 20 percent slopes	410	0.1
Ha	Haynie silt loam, 0 to 2 percent slopes	2,650	0.7
Ju	Judson silt loam, 0 to 2 percent slopes	700	0.2
JuC	Judson silt loam, 2 to 6 percent slopes	18,520	4.7
Ke	Kennebec silt loam, 0 to 1 percent slopes	1,770	0.5
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes	2,220	0.6
KpF	Kipson-Benfield complex, 6 to 20 percent slopes	820	0.2
MaD	Malcolm silt loam, 5 to 11 percent slopes	960	0.2
MaD2	Malcolm silt loam, 5 to 11 percent slopes, eroded	730	0.2
MaF	Malcolm silt loam, 11 to 25 percent slopes	440	0.1
MhC	Marshall silty clay loam, 2 to 5 percent slopes	5,150	1.3
MnD2	Marshall silty clay loam, 5 to 11 percent slopes, eroded	8,880	2.2
MkE	Marshall-Ponca silt loams, 11 to 17 percent slopes	1,430	0.4
MmC	Mayberry clay loam, 3 to 9 percent slopes	5,000	1.3
MoC	Monona silt loam, 2 to 5 percent slopes	1,220	0.3
MoF	Monona silt loam, 17 to 30 percent slopes	1,630	0.4
MpG	Monona-Shelby-Kipson complex, 30 to 70 percent slopes	4,880	1.2
MrD	Morrill clay loam, 5 to 11 percent slopes	2,530	0.6
MsC3	Morrill-Mayberry complex, 3 to 9 percent slopes, severely eroded	18,460	4.7
Nc	Nodaway silt loam, 0 to 1 percent slopes	5,240	1.3
Nd	Nodaway-Colo complex, 0 to 2 percent slopes	35,400	8.9
Oc	Onawa silt loam, overwash, 0 to 1 percent slopes	910	0.2
On	Onawa silty clay, 0 to 1 percent slopes	1,970	0.5
PaC	Pawnee clay loam, 3 to 9 percent slopes	15,410	3.9
PaD	Pawnee clay loam, 9 to 12 percent slopes	770	0.2
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded	33,400	8.4
PbD2	Pawnee clay, 9 to 12 percent slopes, eroded	940	0.2
Pf	Pits	130	*
PwD2	Ponca-Dow silt loams, 5 to 11 percent slopes, eroded	1,920	0.5
PwE2	Ponca-Dow silt loams, 11 to 17 percent slopes, eroded	1,880	0.5
SaB	Sarpy-Haynie complex, 0 to 3 percent slopes	2,150	0.5
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes	1,160	0.3
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes	11,390	2.9
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded	850	0.2
ShD2	Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded	33,130	8.4
SkF	Shelby clay loam, 15 to 30 percent slopes	3,460	0.9
SrE	Shelby and Burchard clay loams, 9 to 15 percent slopes	9,230	2.3
StF	Steinauer clay loam, 11 to 20 percent slopes	1,100	0.3
Wa	Wabash silty clay, 0 to 1 percent slopes	2,100	0.5
Wt	Wymore silty clay loam, 0 to 2 percent slopes	9,840	2.5
WtC2	Wymore silty clay, 2 to 7 percent slopes, eroded	122,146	30.8
Zh	Zoe silty clay loam, 0 to 1 percent slopes	1,220	0.3
Zo	Zook silty clay loam, 0 to 1 percent slopes	15,300	3.9
	Water	3,290	0.8
	Total	396,416	100.0

* Less than 0.1 percent.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE

[Yields are those that can be expected under a high level of management. Absence of a yield indicates that the soil is not suited to the crop or the crop generally is not grown on the soil]

Soil name and map symbol	Corn	Grain sorghum	Winter wheat	Soybeans	Alfalfa hay	Cool season grass
	Bu	Bu	Bu	Bu	Ton	AUM*
Ab----------------------- Albaton	65	70	---	30	3.8	4.0
Co----------------------- Colo	98	100	---	40	4.5	5.5
DcD---------------------- Dickinson	55	75	30	25	3.0	4.0
DcF---------------------- Dickinson	---	---	---	---	---	---
Ha----------------------- Haynie	100	100	38	38	5.0	5.8
Ju----------------------- Judson	110	110	42	43	5.0	6.0
JuC---------------------- Judson	108	108	40	42	4.8	5.8
Ke----------------------- Kennebec	115	110	42	44	5.0	6.0
KnB---------------------- Kennebec-Nodaway	100	100	40	40	4.8	5.8
KpF---------------------- Kipson-Benfield	---	---	---	---	---	---
MaD---------------------- Malcolm	70	80	34	30	3.6	4.5
MaD2--------------------- Malcolm	60	70	30	25	3.3	4.0
MaF---------------------- Malcolm	---	---	---	---	---	---
MhC---------------------- Marshall	100	100	40	40	4.8	5.5
MhD2--------------------- Marshall	90	90	37	34	4.2	4.5
MkE---------------------- Marshall-Ponca	72	75	35	29	3.8	4.0
MmC---------------------- Mayberry	65	75	35	27	3.5	4.0
MoC---------------------- Monona	100	100	40	40	4.8	---
MoF---------------------- Monona	---	---	---	---	---	---
MpG---------------------- Monona-Shelby-Kipson	---	---	---	---	---	---
MrD---------------------- Morrill	70	80	36	27	3.7	5.0

See footnote at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Grain sorghum	Winter wheat	Soybeans	Alfalfa hay	Cool season grass
	Bu	Bu	Bu	Bu	Ton	AUM*
MsC3: Morrill-Mayberry	65	75	34	27	3.5	4.5
No: Nodaway	105	105	40	42	5.0	5.5
Nd: Nodaway-Colo	90	90	---	38	4.5	5.5
Oc: Onawa	90	95	---	40	5.0	5.5
On: Onawa	80	85	---	38	4.8	5.8
PaC: Pawnee	65	75	35	27	3.5	4.0
PaD: Pawnee	60	70	32	25	3.2	3.5
PbC2: Pawnee	58	70	32	25	3.0	3.5
PbD2: Pawnee	---	---	---	---	---	---
Pf**. Pits						
PwD2: Ponca-Dow	85	90	37	32	4.2	4.5
PwE2: Ponca-Dow	70	70	34	28	3.8	4.0
SaB: Sarpy-Haynie	50	---	25	25	3.0	3.5
Sh: Sharpsburg	98	98	45	40	4.8	5.8
ShC: Sharpsburg	90	95	42	37	4.5	5.5
ShC2: Sharpsburg	87	92	40	35	4.3	5.2
ShD2: Sharpsburg	80	90	37	32	4.3	4.5
SkF: Shelby	---	---	---	---	---	---
SrE: Shelby and Burchard	60	73	33	25	4.2	4.0
StF: Steinauer	---	---	---	---	---	---
Wa: Wabash	65	85	---	35	---	4.0
Wt: Wymore	80	90	42	35	4.0	4.5
WtC2: Wymore	75	85	37	30	3.5	4.0

See footnotes at end of table.

TABLE 5.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Grain sorghum	Winter wheat	Soybeans	Alfalfa hay	Cool season grass
	Bu	Bu	Bu	Bu	Ton	AUM*
Zh-------------------------- Zoe	56	66	21	23	2.8	3.2
Zo-------------------------- Zook	100	100	---	38	4.5	5.5

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for 30 days.
** See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 6.--CAPABILITY CLASSES AND SUBCLASSES

[Miscellaneous areas are excluded. Absence of an entry indicates no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	3,630	---	---	---
II	112,090	37,130	65,120	9,840
III	193,806	189,976	3,830	---
IV	69,790	66,420	1,220	3,370
V	---	---	---	---
VI	8,800	7,980	---	820
VII	4,880	4,880	---	---
VIII	130	---	---	130

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; > means more than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Ab: Albaton	Redosier dogwood	Common chokecherry, American plum.	Common hackberry, eastern redcedar.	Golden willow, northern red oak, green ash, Austrian pine, silver maple, honeylocust.	Eastern cottonwood.
Co: Colo	Redosier dogwood	Common chokecherry, American plum.	Eastern redcedar, common hackberry.	Silver maple, Austrian pine, golden willow, honeylocust, green ash, northern red oak.	Eastern cottonwood.
DcD, DcF: Dickinson	American plum, Amur honeysuckle, Peking cotoneaster.	Fragrant sumac	Eastern redcedar, Russian mulberry.	Green ash, honeylocust, common hackberry, Austrian pine, Scotch pine, jack pine.	---
Ha: Haynie	---	Amur honeysuckle, American plum, Peking cotoneaster, lilac.	Eastern redcedar	Austrian pine, green ash, common hackberry, honeylocust, eastern white pine, bur oak.	Eastern cottonwood.
Ju, JuC: Judson	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Bur oak, common hackberry, eastern redcedar, Russian mulberry, green ash.	Austrian pine, honeylocust, Scotch pine.	---
Ke: Kennebec	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Green ash, eastern white pine, bur oak, common hackberry, Austrian pine, honeylocust.	Eastern cottonwood.
KnB*: Kennebec	---	American plum, lilac, Peking cotoneaster, Amur honeysuckle.	Eastern redcedar	Green ash, eastern white pine, bur oak, common hackberry, Austrian pine, honeylocust.	Eastern cottonwood.
Nodaway	---	Amur honeysuckle, Peking cotoneaster, American plum, lilac.	Eastern redcedar	Austrian pine, common hackberry, honeylocust, green ash, eastern white pine, bur oak.	Eastern cottonwood.
KpF*: Kipson.					
Benfield	Siberian peashrub, Peking cotoneaster, lilac.	Amur honeysuckle	Eastern redcedar, Austrian pine, Russian-olive, common hackberry, green ash.	Siberian elm, honeylocust.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
MaD, MaD2, MaF: Malcolm	Peking cotoneaster, lilac.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, green ash, bur oak, common hackberry, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
MhC, MhD2: Marshall	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Eastern redcedar, Russian mulberry, common hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---
MkE*:					
Marshall	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Eastern redcedar, Russian mulberry, common hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---
Ponca	Lilac, Peking cotoneaster.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, green ash, common hackberry, bur oak, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
MmC: Mayberry	Siberian peashrub, Amur honeysuckle, lilac, Peking cotoneaster.	Eastern redcedar, midwest Manchurian crabapple.	Russian-olive, Austrian pine, green ash, common hackberry, honeylocust.	Siberian elm	---
MoC: Monona	Peking cotoneaster, lilac.	Skunkbush sumac, Amur honeysuckle.	Bur oak, common hackberry, green ash, Russian mulberry, eastern redcedar.	Honeylocust, Scotch pine, Austrian pine.	---
MoF. Monona					
MpG*:					
Monona.					
Shelby.					
Kipson.					
MrD: Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, common hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
MsC3*:					
Morrill	Peking cotoneaster	Amur honeysuckle, lilac, fragrant sumac.	Green ash, common hackberry, Russian-olive, eastern redcedar, bur oak.	Austrian pine, honeylocust, Scotch pine.	---
Mayberry	Siberian peashrub, Amur honeysuckle, lilac, Peking cotoneaster.	Eastern redcedar, midwest Manchurian crabapple.	Russian-olive, Austrian pine, green ash, common hackberry, honeylocust.	Siberian elm	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of-- <8	8-15	16-25	26-35	>35
Nc----------------- Nodaway	---	Amur honeysuckle, Peking cotoneaster, American plum, lilac.	Eastern redcedar	Austrian pine, common hackberry, honeylocust, green ash, eastern white pine, bur oak.	Eastern cottonwood.
Nd*: Nodaway-----------	---	Amur honeysuckle, Peking cotoneaster, American plum, lilac.	Eastern redcedar	Austrian pine, common hackberry, honeylocust, green ash, eastern white pine, bur oak.	Eastern cottonwood.
Colo--------------	Redosier dogwood	Common chokecherry, American plum.	Eastern redcedar, common hackberry.	Silver maple, Austrian pine, golden willow, honeylocust, green ash, northern red oak.	Eastern cottonwood.
Oc, On------------ Onawa	Redosier dogwood	Common chokecherry, American plum.	Common hackberry, eastern redcedar.	Golden willow, silver maple, green ash, Austrian pine, honeylocust, northern red oak.	Eastern cottonwood.
PaC, PaD, PbC2, PbD2-------------- Pawnee	Common hackberry, Amur honeysuckle, lilac, Siberian peashrub, Peking cotoneaster.	Eastern redcedar, midwest Manchurian crabapple.	Austrian pine, Russian-olive, green ash, honeylocust.	Siberian elm------	---
Pf*. Pits					
PwD2*, PwE2*: Ponca-------------	Lilac, Peking cotoneaster.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, green ash, common hackberry, bur oak, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
Dow---------------	Tatarian honeysuckle.	Siberian peashrub	Eastern redcedar, osageorange, honeylocust, Russian-olive, northern catalpa, green ash, bur oak, black locust.	Siberian elm------	---
SaB*: Sarpy------------	Peking cotoneaster.	Russian-olive-----	Eastern redcedar, Austrian pine.	---	Eastern cottonwood.
Haynie------------	---	Amur honeysuckle, American plum, Peking cotoneaster, lilac.	Eastern redcedar	Austrian pine, green ash, common hackberry, honeylocust, eastern white pine, bur oak.	Eastern cottonwood.

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average height, in feet, of--				
	<8	8-15	16-25	26-35	>35
Sh, ShC, ShC2, SnD2: Sharpsburg	Peking cotoneaster, lilac, skunkbush sumac.	Amur honeysuckle	Green ash, common hackberry, bur oak, eastern redcedar, Russian mulberry.	Austrian pine, Scotch pine, honeylocust.	---
SkF. Shelby					
SrE*:					
Shelby	Peking cotoneaster, lilac.	Amur honeysuckle, skunkbush sumac.	Eastern redcedar, Russian mulberry, common hackberry, bur oak, green ash.	Austrian pine, Scotch pine, honeylocust.	---
Burchard	Peking cotoneaster	Tatarian honeysuckle, lilac, American plum.	Eastern redcedar, Russian mulberry, green ash, common hackberry, bur oak.	Austrian pine, Scotch pine, honeylocust.	---
StF: Steinauer	American plum, silver buffaloberry.	Tatarian honeysuckle, Russian-olive, common hackberry, eastern redcedar, Siberian peashrub.	Siberian elm, honeylocust, green ash, ponderosa pine.	---	---
Wa: Wabash	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, common hackberry.	Austrian pine, green ash, northern red oak, golden willow, honeylocust, silver maple.	Eastern cottonwood.
Wt, WtC2: Wymore	Peking cotoneaster, skunkbush sumac, lilac.	Amur honeysuckle	Eastern redcedar, Austrian pine, ponderosa pine, Russian-olive, common hackberry, green ash.	Honeylocust	---
Zh: Zoe	Tatarian honeysuckle, lilac, silver buffaloberry.	Eastern redcedar, Siberian peashrub.	Green ash, Russian-olive.	White willow, golden willow, Siberian elm.	Eastern cottonwood.
Zo: Zook	Redosier dogwood	American plum, common chokecherry.	Eastern redcedar, common hackberry.	Honeylocust, golden willow, green ash, northern red oak, silver maple, Austrian pine.	Eastern cottonwood.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 8.--RECREATIONAL DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Ab: Albaton	Severe: flooding, wetness, percs slowly.	Severe: too clayey, percs slowly.	Severe: too clayey, wetness, percs slowly.	Severe: too clayey.	Severe: too clayey.
Co: Colo	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
DcD: Dickinson	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
DcF: Dickinson	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Ha: Haynie	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Ju: Judson	Slight	Slight	Slight	Slight	Slight.
JuC: Judson	Slight	Slight	Moderate: slope.	Slight	Slight.
Ke: Kennebec	Severe: flooding.	Slight	Slight	Slight	Slight.
KnB*:					
Kennebec	Severe: flooding.	Slight	Slight	Slight	Slight.
Nodaway	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
KpF*:					
Kipson	Severe: depth to rock.	Severe: depth to rock.	Severe: small stones, depth to rock.	Slight	Severe: thin layer.
Benfield	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: erodes easily.	Moderate: large stones, slope.
MaD, MaD2: Malcolm	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
MaF: Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
MhC: Marshall	Slight	Slight	Moderate: slope.	Slight	Slight.
MnD2: Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
MkE*:					
Marshall	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ponca	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
MmC------------------- Mayberry	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Severe: erodes easily.	Slight.
MoC------------------- Monona	Slight----------	Slight----------	Moderate: slope.	Slight----------	Slight.
MoF------------------- Monona	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
MpG*:					
Monona---------------	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Shelby---------------	Severe: slope.	Severe: slope.	Severe: slope.		Severe: slope.
Kipson---------------	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: small stones, depth to rock.		Severe: slope, thin layer.
MrD------------------- Morrill	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight----------	Moderate: slope.
MsC3*:					
Morrill--------------	Slight----------	Slight----------	Severe: slope.	Slight----------	Slight.
Mayberry-------------	Severe: too clayey.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey, erodes easily.	Severe: too clayey.
Nc-------------------- Nodaway	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
Nd*:					
Nodaway--------------	Severe: flooding.	Slight----------	Moderate: flooding.	Slight----------	Moderate: flooding.
Colo-----------------	Severe: flooding, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Oc-------------------- Onawa	Severe: flooding.	Moderate: wetness.	Moderate: wetness, flooding.	Slight----------	Moderate: flooding.
On-------------------- Onawa	Severe: flooding, too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.
PaC------------------- Pawnee	Moderate: percs slowly.	Moderate: percs slowly.	Severe: slope.	Severe: erodes easily.	Slight.
PaD------------------- Pawnee	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Severe: erodes easily.	Moderate: slope.
PbC2------------------ Pawnee	Severe: too clayey.	Severe: too clayey.	Severe: too clayey, slope.	Severe: too clayey, erodes easily.	Severe: too clayey.
PbD2------------------ Pawnee	Severe: too clayey.	Severe: too clayey.	Severe: slope, too clayey.	Severe: too clayey, erodes easily.	Severe: too clayey.

See footnote at end of table.

TABLE 8.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Patns and trails	Golf fairways
Pf*. Pits					
PwD2*, PwE2*:					
Ponca	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Dow	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
SaB*:					
Sarpy	Severe: flooding, too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Moderate: droughty, flooding.
Haynie	Severe: flooding.	Slight	Moderate: flooding.	Slight	Moderate: flooding.
Sh Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Slight	Slight.
ShC, ShC2 Sharpsburg	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: slope, percs slowly.	Slight	Slight.
ShD2 Sharpsburg	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
SkF Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
SrE*:					
Shelby	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
Burchard	Moderate: slope, percs slowly.	Moderate: slope, percs slowly.	Severe: slope.	Slight	Moderate: slope.
StF Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
Wa Wabash	Severe: flooding, wetness, percs slowly.	Severe: wetness, too clayey, percs slowly.	Severe: too clayey, wetness.	Severe: wetness, too clayey.	Severe: wetness, too clayey.
Wt Wymore	Moderate: percs slowly.	Moderate: percs slowly.	Moderate: percs slowly.	Severe: erodes easily.	Slight.
WtC2 Wymore	Severe: too clayey.	Severe: too clayey.	Severe: too clayey.	Severe: too clayey, erodes easily.	Severe: too clayey.
Zh Zoe	Severe: flooding, wetness.	Moderate: wetness, percs slowly.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.
Zo Zook	Severe: wetness, flooding.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 9.--WILDLIFE HABITAT

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Ab: Albaton	Fair	Fair	Fair	Poor	Very poor.	Poor	Good	Good	Fair	Poor	Good	Fair.
Co: Colo	Good	Fair	Good	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Good.
DcD: Dickinson	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
DcF: Dickinson	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
Ha: Haynie	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ju, JuC: Judson	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Ke: Kennebec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
KnB*:												
Kennebec	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Nodaway	Good	Good	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair	Good.
KpF*:												
Kipson	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Fair	Poor	Very poor.	Poor.
Benfield	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
MaD, MaD2: Malcolm	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MaF: Malcolm	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
MhC: Marshall	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MhD2: Marshall	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MkE*:												
Marshall	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Ponca	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MmC: Mayberry	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
MoC: Monona	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
MoF: Monona	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
MpG*:												
Monona	Poor	Poor	Fair	Poor	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.	Poor.
Shelby	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
Kipson	Poor	Fair	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Poor.
MrD Morrill	Fair	Good	Good	Fair	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
MsC3*:												
Morrill	Fair	Good	Good	Fair	Fair	Good	Very poor.	Very poor.	Good	Fair	Very poor.	Good.
Mayberry	Fair	Good	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
Nc Nodaway	Good	Good	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair	Good.
Nd*:												
Nodaway	Good	Good	Good	Good	Fair	Good	Fair	Poor	Fair	Good	Fair	Good.
Colo	Good	Fair	Good	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Good.
Oc, On Onawa	Fair	Fair	Fair	Poor	Very poor.	Poor	Good	Good	Fair	Poor	Fair	Fair.
PaC, PaD, PbC2, PbD2 Pawnee	Fair	Good	Good	Fair	Fair	Fair	Very poor.	Very poor.	Good	Fair	Very poor.	Fair.
Pf*. Pits												
PwD2*, PwE2*:												
Ponca	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
Dow	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
SaB*:												
Sarpy	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.	Fair.
Haynie	Good	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor	Good.
Sh, ShC, ShC2 Sharpsburg	Good	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
SnD2 Sharpsburg	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.
SkF Shelby	Poor	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.	Fair.
SrE*:												
Shelby	Fair	Good	Fair	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Burchard	Fair	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.	Good.

See footnote at end of table.

TABLE 9.--WILDLIFE HABITAT--Continued

Soil name and map symbol	Potential for habitat elements: Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Shrubs	Wetland plants	Shallow water areas	Potential as habitat for--: Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
StF Steinauer	Poor	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Fair	Good	Very poor.	Good.
Wa Wabash	Poor	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good	Poor.
Wt Wymore	Good	Good	Fair	Good	Good	Fair	Poor	Very poor.	Good	Good	Very poor.	Fair.
WtC2 Wymore	Fair	Good	Fair	Good	Good	Fair	Very poor.	Very poor.	Fair	Good	Very poor.	Fair.
Zh Zoe	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Fair	Poor	Poor	Fair	Fair.
Zo Zook	Good	Fair	Good	Fair	Poor	Fair	Fair	Fair	Fair	Fair	Fair	Good.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 10.--BUILDING SITE DEVELOPMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Ab: Albaton	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, shrink-swell.	Severe: too clayey.
Co: Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
DcD: Dickinson	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
DcF: Dickinson	Severe: cutbanks cave, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.
Ha: Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Ju: Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
JuC: Judson	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
Ke: Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
KnB*:						
Kennebec	Moderate: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, frost action.	Slight.
Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
KpF*:						
Kipson	Severe: depth to rock.	Moderate: shrink-swell, slope, depth to rock.	Severe: depth to rock.	Severe: slope.	Moderate: depth to rock, slope, frost action.	Severe: thin layer.
Benfield	Moderate: depth to rock, too clayey, slope.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, slope.	Severe: low strength, shrink-swell.	Moderate: large stones, slope.
MaD, MaD2: Malcolm	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope.	Severe: slope.	Severe: frost action, low strength.	Moderate: slope.
MaF: Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, frost action, low strength.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
MhC: Marshall	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Severe: low strength, frost action.	Slight.
MhD2: Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MkE*: Marshall	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Ponca	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
MmC: Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
MoC: Monona	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength, frost action.	Slight.
MoF: Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
MpG*: Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope, frost action.	Severe: slope.
Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.
Kipson	Severe: depth to rock, slope.	Severe: slope.	Severe: depth to rock, slope.	Severe: slope.	Severe: slope.	Severe: slope, thin layer.
MrD: Morrill	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
MsC3*: Morrill	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.	Slight.
Mayberry	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
Nc: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.
Nd*: Nodaway	Moderate: wetness, flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, frost action, low strength.	Moderate: flooding.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Nd*:						
Colo	Severe: wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.
Oc Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength, frost action.	Moderate: flooding.
On Onawa	Severe: wetness.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding, low strength, frost action.	Severe: too clayey.
PaC Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: wetness.
PaD Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, slope, wetness.	Severe: low strength, frost action, shrink-swell.	Moderate: slope, wetness.
PbC2 Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
PbD2 Pawnee	Severe: wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, wetness.	Severe: shrink-swell, slope, wetness.	Severe: low strength, frost action, shrink-swell.	Severe: too clayey.
Pf*. Pits						
PwD2*, PwE2*:						
Ponca	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength, frost action.	Moderate: slope.
Dow	Moderate: slope.	Moderate: slope.	Moderate: slope.	Severe: slope.	Severe: frost action.	Moderate: slope.
SaB*:						
Sarpy	Severe: cutbanks cave.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Moderate: droughty, flooding.
Haynie	Moderate: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: low strength, flooding, frost action.	Moderate: flooding.
Sh, ShC, ShC2 Sharpsburg	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: low strength, frost action.	Slight.
ShD2 Sharpsburg	Moderate: too clayey, slope.	Severe: shrink-swell, slope.	Severe: slope, shrink-swell.	Severe: slope, shrink-swell.	Severe: low strength, frost action.	Moderate: slope.
SkF Shelby	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: low strength, slope.	Severe: slope.

See footnote at end of table.

TABLE 10.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
SrE*:						
Shelby	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
Burchard	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Severe: low strength.	Moderate: slope.
StF Steinauer	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope, low strength.	Severe: slope.
Wa Wabash	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, wetness, flooding.	Severe: wetness, too clayey.
Wt Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Moderate: wetness.
WtC2 Wymore	Severe: wetness.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: low strength, frost action.	Severe: too clayey.
Zh Zoe	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: low strength, flooding, frost action.	Moderate: wetness, flooding.
Zo Zook	Severe: wetness.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, wetness, shrink-swell.	Severe: flooding, low strength, frost action.	Moderate: wetness, flooding.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 11.--SANITARY FACILITIES

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms. Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ab: Albaton	Severe: flooding, wetness, percs slowly.	Severe: flooding, wetness.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Co: Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
DcD: Dickinson	Severe: poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: seepage, too sandy.
DcF: Dickinson	Severe: slope, poor filter.	Severe: seepage, slope.	Severe: seepage, too sandy, slope.	Severe: seepage, slope.	Poor: slope, seepage, too sandy.
Ha: Haynie	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Ju: Judson	Slight	Moderate: seepage.	Slight	Slight	Good.
JuC: Judson	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
Ke: Kennebec	Moderate: flooding, wetness.	Severe: flooding.	Severe: wetness.	Moderate: flooding, wetness.	Good.
KnB*:					
Kennebec	Moderate: flooding, wetness.	Severe: flooding.	Severe: wetness.	Moderate: flooding, wetness.	Good.
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
KpF*:					
Kipson	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: depth to rock.	Poor: area reclaim, small stones.
Benfield	Severe: depth to rock, percs slowly.	Severe: depth to rock, slope.	Severe: depth to rock, too clayey.	Severe: depth to rock.	Poor: area reclaim, too clayey, hard to pack.
MaD, MaD2: Malcolm	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MaF: Malcolm	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
MhC: Marshall	Slight	Moderate: seepage, slope.	Slight	Slight	Good.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
MhD2: Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
MkE*:					
Marshall	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
Ponca	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
MmC: Mayberry	Severe: percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
MoC: Monona	Slight	Moderate: seepage, slope.	Slight	Slight	Good.
MoF: Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
MpG*:					
Monona	Severe: slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
Kipson	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Poor: area reclaim, small stones, slope.
MrD: Morrill	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
MsC3*:					
Morrill	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Mayberry	Severe: percs slowly.	Moderate: slope.	Severe: wetness, too clayey.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
No: Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Nd*:					
Nodaway	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Severe: flooding, wetness.	Fair: wetness.
Colo	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Severe: wetness, flooding.	Poor: wetness, hard to pack.
Oc, On: Onawa	Severe: wetness, flooding.	Severe: wetness, seepage, flooding.	Severe: flooding, seepage, wetness.	Severe: wetness, flooding, seepage.	Fair: wetness.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
PaC----------------- Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PaD----------------- Pawnee	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PbC2---------------- Pawnee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
PbD2---------------- Pawnee	Severe: percs slowly, wetness.	Severe: slope.	Severe: too clayey, wetness.	Severe: wetness.	Poor: too clayey, hard to pack, wetness.
Pf*. Pits					
PwD2*, PwE2*:					
Ponca---------------	Moderate: slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
Dow-----------------	Moderate: slope.	Severe: slope.	Moderate: slope.	Moderate: slope.	Fair: slope.
SaB*:					
Sarpy---------------	Severe: flooding, poor filter.	Severe: seepage, flooding.	Severe: flooding, seepage, too sandy.	Severe: flooding, seepage.	Poor: seepage, too sandy.
Haynie--------------	Severe: flooding.	Severe: flooding.	Severe: flooding.	Severe: flooding.	Good.
Sh------------------ Sharpsburg	Moderate: percs slowly.	Moderate: seepage.	Moderate: too clayey.	Slight------------	Fair: too clayey.
ShC, ShC2----------- Sharpsburg	Moderate: percs slowly.	Moderate: seepage, slope.	Moderate: too clayey.	Slight------------	Fair: too clayey.
ShD2---------------- Sharpsburg	Moderate: percs slowly, slope.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
SkF----------------- Shelby	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.
SrE*:					
Shelby--------------	Severe: percs slowly.	Severe: slope.	Moderate: too clayey, slope.	Moderate: slope.	Fair: too clayey, slope.
Burchard------------	Severe: percs slowly.	Severe: slope.	Moderate: slope, too clayey.	Moderate: slope.	Fair: too clayey, slope.
StF----------------- Steinauer	Severe: percs slowly, slope.	Severe: slope.	Severe: slope.	Severe: slope.	Poor: slope.

See footnote at end of table.

TABLE 11.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Wa: Wabash	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Wt: Wymore	Severe: percs slowly.	Slight	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
WtC2: Wymore	Severe: percs slowly.	Moderate: slope.	Severe: wetness.	Severe: wetness.	Poor: hard to pack, wetness.
Zh: Zoe	Severe: flooding, wetness, percs slowly.	Severe: flooding.	Severe: flooding, wetness, too clayey.	Severe: flooding, wetness.	Poor: too clayey, hard to pack, wetness.
Zo: Zook	Severe: percs slowly, wetness, flooding.	Severe: flooding.	Severe: wetness, too clayey, flooding.	Severe: wetness, flooding.	Poor: too clayey, wetness, hard to pack.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 12.--CONSTRUCTION MATERIALS

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," "probable," and "improbable." Absence of an entry indicates that the soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ab-- Albaton	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Co-- Colo	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
DcD-- Dickinson	Good	Probable	Improbable: too sandy.	Fair: slope.
DcF-- Dickinson	Fair: slope.	Probable	Improbable: too sandy.	Poor: slope.
Ha-- Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ju, JuC-- Judson	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Ke-- Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
KnB*:				
Kennebec	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
KpF*:				
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones.
Benfield	Poor: area reclaim, low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: small stones.
MaD, MaD2-- Malcolm	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MaF-- Malcolm	Fair: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MhC-- Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
MhD2-- Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MkE*:				
Marshall	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Ponca	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
MmC-- Mayberry	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, small stones.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
MoC: Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.
MoF: Monona	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
MpG*:				
Monona	Poor: low strength, slope.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Severe: slope.
Kipson	Poor: area reclaim.	Improbable: excess fines.	Improbable: excess fines.	Poor: area reclaim, small stones, slope.
MrD: Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones, slope.
MsC3*:				
Morrill	Good	Improbable: excess fines.	Improbable: excess fines.	Fair: small stones.
Mayberry	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Nc: Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Nd*:				
Nodaway	Good	Improbable: excess fines.	Improbable: excess fines.	Good.
Colo	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Good.
Oc, On: Onawa	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
PaC, PaD, PbC2, PbD2: Pawnee	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Pf*. Pits				
PwD2*, PwE2*:				
Ponca	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
Dow	Fair: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: slope.
SaB*:				
Sarpy	Good	Probable	Improbable: too sandy.	Poor: too sandy.
Haynie	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Good.

See footnote at end of table.

TABLE 12.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Sh, ShC, ShC2, ShD2---Sharpsburg	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.
SkF---Shelby	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Severe: slope.
SrE*:				
Shelby---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, slope.
Burchard---	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey, small stones, slope.
StF---Steinauer	Poor: low strength.	Improbable: excess fines.	Improbable: excess fines.	Poor: slope.
Wa---Wabash	Poor: low strength, wetness, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey, wetness.
Wt, WtC2---Wymore	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: too clayey.
Zh---Zoe	Poor: low strength, shrink-swell.	Improbable: excess fines.	Improbable: excess fines.	Poor: thin layer, too clayey.
Zo---Zook	Poor: shrink-swell, low strength.	Improbable: excess fines.	Improbable: excess fines.	Fair: too clayey.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 13.--WATER MANAGEMENT

[Some terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not evaluated]

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
Ab----------------- Albaton	Slight---------	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, slow intake, percs slowly.	Not needed-----	Not needed.
Co----------------- Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness---------	Wetness.
DcD, DcF----------- Dickinson	Severe: slope, seepage.	Severe: seepage.	Deep to water	Soil blowing, slope.	Soil blowing, too sandy, slope.	Slope.
Ha----------------- Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily, flooding.	Erodes easily	Erodes easily.
Ju----------------- Judson	Moderate: seepage.	Severe: piping.	Deep to water	Favorable------	Erodes easily	Erodes easily.
JuC---------------- Judson	Moderate: seepage, slope.	Severe: piping.	Deep to water	Slope----------	Erodes easily	Erodes easily.
Ke----------------- Kennebec	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable------	Favorable------	Favorable.
KnB*:						
Kennebec----------	Moderate: seepage.	Moderate: thin layer, piping.	Deep to water	Favorable------	Favorable------	Favorable.
Nodaway-----------	Moderate: seepage.	Severe: piping.	Flooding-------	Flooding, erodes easily.	Erodes easily	Erodes easily.
KpF*:						
Kipson------------	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
Benfield----------	Severe: slope.	Moderate: thin layer, hard to pack.	Deep to water	Percs slowly, depth to rock, slope.	Slope, depth to rock, erodes easily.	Slope, erodes easily, depth to rock.
MaD, MaD2, MaF---- Malcolm	Severe: slope.	Severe: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
MhC---------------- Marshall	Moderate: seepage, slope.	Slight---------	Deep to water	Slope----------	Erodes easily	Erodes easily.
MhD2--------------- Marshall	Severe: slope.	Slight---------	Deep to water	Slope----------	Erodes easily, slope.	Slope, erodes easily.
MkE*:						
Marshall----------	Severe: slope.	Slight---------	Deep to water	Slope----------	Erodes easily, slope.	Slope, erodes easily.
Ponca-------------	Severe: slope.	Moderate: piping.	Deep to water	Slope----------	Slope, erodes easily.	Slope, erodes easily.
MmC---------------- Mayberry	Moderate: slope.	Moderate: hard to pack.	Percs slowly, frost action, slope.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Limitations for-- Embankments, dikes, and levees	Features affecting-- Drainage	Features affecting-- Irrigation	Features affecting-- Terraces and diversions	Features affecting-- Grassed waterways
MoC: Monona	Moderate: seepage, slope.	Moderate: piping.	Deep to water	Slope	Erodes easily	Erodes easily.
MoF: Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
MpG*:						
Monona	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Kipson	Severe: depth to rock, slope.	Severe: piping.	Deep to water	Depth to rock, slope.	Slope, large stones, depth to rock.	Large stones, slope, depth to rock.
MrD: Morrill	Severe: slope.	Severe: thin layer.	Deep to water	Slope	Slope	Slope.
MsC3*:						
Morrill	Moderate: seepage, slope.	Severe: thin layer.	Deep to water	Slope	Favorable	Favorable.
Mayberry	Moderate: slope.	Moderate: hard to pack.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Nc: Nodaway	Moderate: seepage.	Severe: piping.	Flooding	Flooding, erodes easily.	Erodes easily	Erodes easily.
Nd*:						
Nodaway	Moderate: seepage.	Severe: piping.	Flooding	Flooding, erodes easily.	Erodes easily	Erodes easily.
Colo	Moderate: seepage.	Severe: wetness.	Flooding, frost action.	Flooding, wetness.	Wetness	Wetness.
Oc: Onawa	Severe: seepage.	Severe: piping.	Flooding, frost action.	Wetness, flooding.	Not needed	Not needed.
On: Onawa	Severe: seepage.	Severe: piping.	Flooding, frost action.	Wetness, slow intake, percs slowly.	Not needed	Not needed.
PaC: Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
PaD: Pawnee	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Percs slowly, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily.
PbC2: Pawnee	Moderate: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slow intake, percs slowly, erodes easily.	Erodes easily, percs slowly.	Erodes easily.
PbD2: Pawnee	Severe: slope.	Severe: hard to pack.	Percs slowly, frost action, slope.	Slow intake, percs slowly, erodes easily.	Slope, erodes easily, percs slowly.	Slope, erodes easily.
Pf*. Pits						

See footnote at end of table.

TABLE 13.--WATER MANAGEMENT--Continued

Soil name and map symbol	Limitations for-- Pond reservoir areas	Embankments, dikes, and levees	Features affecting-- Drainage	Irrigation	Terraces and diversions	Grassed waterways
PwD2*, PwE2*:						
Ponca	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
Dow	Severe: slope.	Severe: piping.	Deep to water	Erodes easily, slope.	Slope, erodes easily.	Slope, erodes easily.
SaB*:						
Sarpy	Severe: seepage.	Severe: seepage, piping.	Deep to water	Droughty, fast intake, soil blowing.	Too sandy, soil blowing.	Droughty.
Haynie	Moderate: seepage.	Severe: piping.	Deep to water	Erodes easily, flooding.	Erodes easily	Erodes easily.
Sh Sharpsburg	Moderate: seepage.	Slight	Deep to water	Favorable	Erodes easily	Erodes easily.
ShC, ShC2 Sharpsburg	Moderate: seepage, slope.	Slight	Deep to water	Slope	Erodes easily	Erodes easily.
ShD2 Sharpsburg	Severe: slope.	Slight	Deep to water	Slope	Slope, erodes easily.	Slope, erodes easily.
SkF Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
SrE*:						
Shelby	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
Burchard	Severe: slope.	Slight	Deep to water	Slope	Slope	Slope.
StF Steinauer	Severe: slope.	Moderate: piping.	Deep to water	Slope	Slope	Slope.
Wa Wabash	Slight	Severe: hard to pack, wetness.	Percs slowly, flooding.	Wetness, droughty, slow intake.	Wetness, percs slowly.	Wetness, droughty, percs slowly.
Wt Wymore	Slight	Moderate: hard to pack.	Percs slowly, frost action.	Wetness, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
WtC2 Wymore	Moderate: slope.	Moderate: hard to pack.	Percs slowly, frost action, slope.	Wetness, slow intake, percs slowly.	Erodes easily, wetness.	Wetness, erodes easily.
Zh Zoe	Slight	Severe: wetness.	Percs slowly, flooding, frost action.	Wetness, percs slowly, flooding.	Wetness, percs slowly.	Wetness, percs slowly.
Zo Zook	Slight	Severe: hard to pack, wetness.	Flooding, percs slowly, frost action.	Wetness, percs slowly.	Not needed	Not needed.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 14.--ENGINEERING INDEX PROPERTIES

[The symbol > means more than. Absence of an entry indicates that data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ab-------------- Albaton	0-9	Silty clay-------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	9-60	Silty clay, clay	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
Co-------------- Colo	0-52	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	90-100	35-50	15-30
	52-60	Silty clay loam, clay loam.	CL, CH	A-7, A-6	0	100	100	95-100	80-100	35-55	15-30
DcD------------- Dickinson	0-12	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	100	100	85-100	30-50	15-30	NP-10
	12-38	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4, A-2	0	100	100	85-100	25-40	15-30	NP-10
	38-60	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-100	5-27	10-20	NP-5
DcF------------- Dickinson	0-10	Fine sandy loam	SM, SC, SM-SC	A-4, A-2	0	95-100	95-100	85-100	30-50	15-30	NP-10
	10-24	Fine sandy loam, sandy loam.	SM, SC, SM-SC	A-4, A-2	0	100	100	85-100	25-40	15-30	NP-10
	24-32	Loamy sand, loamy fine sand, fine sand.	SM, SP-SM, SM-SC	A-2, A-3	0	100	100	80-100	5-20	10-20	NP-5
	32-60	Sand, loamy fine sand, loamy sand.	SM, SP-SM	A-3, A-2	0	100	100	70-95	5-27	---	NP
Ha-------------- Haynie	0-7	Silt loam--------	CL-ML, ML, CL	A-4, A-6	0	100	100	85-100	70-100	25-40	5-15
	7-60	Silt loam, very fine sandy loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	85-100	85-100	25-35	5-15
Ju, JuC---------- Judson	0-34	Silt loam--------	CL, CL-ML, ML	A-6, A-7, A-4	0	100	100	100	95-100	25-50	5-25
	34-60	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	30-50	15-25
Ke-------------- Kennebec	0-42	Silt loam--------	CL, ML	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	42-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	90-100	25-50	5-25
KnB*:											
Kennebec--------	0-37	Silt loam--------	CL, ML	A-6, A-7	0	100	100	95-100	90-100	25-45	10-20
	37-60	Silt loam, silty clay loam.	CL, CL-ML	A-4, A-6, A-7	0	100	100	95-100	90-100	25-50	5-25
Nodaway---------	0-60	Silt loam--------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
KpF*:											
Kipson----------	0-15	Silt loam--------	CL-ML, CL	A-4, A-6	0-25	80-100	70-100	65-95	60-95	25-35	5-15
	15-20	Shaly silt loam, shaly silty clay loam, shaly loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	20-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
Benfield--------	0-7	Silty clay loam	CL	A-6, A-7	0-15	85-100	85-100	85-95	85-95	30-50	11-25
	7-36	Silty clay, silty clay loam.	CH, CL	A-7-6	0-15	85-100	70-100	70-95	70-95	40-60	20-35
	36-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
MaD, MaD2, MaF---	0-7	Silt loam--------	CL, ML	A-4, A-6, A-7	0	100	100	95-100	70-95	25-50	5-20
Malcolm	7-28	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	95-100	70-100	35-55	10-27
	28-60	Silt loam, very fine sandy loam.	ML, CL, CL-ML	A-4	0	100	100	95-100	70-100	20-35	2-10

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
MhC, MhD2--------- Marshall	0-7	Silty clay loam	CL	A-6, A-7	0	100	100	100	95-100	35-50	12-25
	7-46	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-52	15-25
	46-60	Silt loam, silty clay loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
MkE*:											
Marshall---------	0-10	Silt loam---------	CL, CL-ML	A-4, A-6	0	100	100	100	95-100	25-40	5-15
	10-40	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-52	15-25
	40-60	Silt loam---------	CL	A-7, A-6	0	100	100	100	95-100	35-50	15-25
Ponca------------	0-10	Silt loam---------	CL	A-6, A-7	0	100	100	100	95-100	30-45	11-25
	10-25	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	25-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	30-45	11-25
MmC--------------- Mayberry	0-10	Clay loam---------	CL	A-6, A-7	0	100	95-100	90-100	75-100	35-45	15-25
	10-60	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	60-80	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30
MoC--------------- Monona	0-12	Silt loam---------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	12-36	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	36-64	Silt loam---------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
MoF--------------- Monona	0-14	Silt loam---------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	14-36	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	36-60	Silt loam---------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
MpG*:											
Monona-----------	0-5	Silt loam---------	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	5-30	Silt loam, silty clay loam.	ML, CL	A-6, A-7	0	100	100	95-100	95-100	35-50	10-25
	30-60	Silt loam---------	CL	A-6	0	100	100	95-100	95-100	30-40	10-20
Shelby-----------	0-10	Clay loam---------	CL	A-6, A-7-6	0	90-95	85-95	75-90	55-70	35-45	15-25
	10-40	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
	40-60	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
Kipson-----------	0-13	Silt loam---------	CL-ML, CL	A-4, A-6, A-7	0-25	80-100	70-100	65-95	60-95	25-45	5-18
	13-20	Shaly silt loam, shaly silty clay loam, shaly loam.	CL-ML, CL	A-6, A-4	0-25	70-100	60-100	55-100	50-95	25-40	5-20
	20-60	Weathered bedrock	---	---	---	---	---	---	---	---	---
MrD--------------- Morrill	0-10	Clay loam---------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-40	7-15
	10-48	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
	48-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
MsC3*:											
Morrill----------	0-7	Clay loam---------	CL	A-4, A-6	0	95-100	80-100	70-100	50-75	25-40	7-15
	7-43	Clay loam, sandy clay loam, gravelly clay loam.	CL, SC	A-6, A-7-6	0	90-100	70-100	60-100	35-80	30-45	11-25
	43-60	Loam, clay loam, sandy loam.	CL, ML, SM, SC	A-4, A-6, A-2	0	90-100	70-100	60-100	30-80	20-35	2-15
Mayberry---------	0-5	Clay--------------	CH, CL	A-7	0	100	100	90-100	90-100	45-60	25-35
	5-40	Clay, sandy clay	CL, CH	A-7	0	100	90-100	80-100	60-100	45-60	25-35
	40-60	Stratified sandy loam to clay.	CL, CH	A-6, A-7	0	95-100	95-100	85-95	70-95	35-60	15-30

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Nc----------------- Nodaway	0-60	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
Nd*:											
Nodaway----------	0-60	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	95-100	95-100	90-100	25-40	5-15
Colo-------------	0-54	Silty clay loam	CL	A-7, A-6	0	100	100	90-100	90-100	35-50	15-30
	54-60	Silty clay loam, clay loam.	CL, CH	A-7, A-6	0	100	100	95-100	80-100	35-55	15-30
Oc----------------- Onawa	0-7	Silt loam---------	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	90-100	25-40	5-20
	7-28	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	28-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
On----------------- Onawa	0-6	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	6-21	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	60-85	40-60
	21-60	Silt loam, very fine sandy loam, loam.	CL, CL-ML, ML	A-4, A-6	0	100	100	95-100	85-100	25-40	5-20
PaC, PaD---------- Pawnee	0-12	Clay loam---------	CL	A-6	0	95-100	95-100	85-100	70-90	30-40	10-20
	12-56	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	56-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
PbC2, PbD2-------- Pawnee	0-7	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	7-45	Clay--------------	CH	A-7	0	95-100	95-100	85-100	70-85	50-70	25-45
	45-60	Clay loam, sandy clay loam.	CL, CH	A-7, A-6	0	95-100	95-100	80-100	70-90	35-55	20-40
Pf*. Pits											
PwD2*, PwE2*:											
Ponca------------	0-8	Silt loam---------	CL	A-6, A-7	0	100	100	100	95-100	30-45	11-25
	8-18	Silty clay loam, silt loam.	CL	A-7, A-6	0	100	100	100	95-100	35-50	20-30
	18-60	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	100	95-100	30-45	11-25
Dow--------------	0-6	Silt loam---------	CL, ML	A-4, A-6	0	100	100	95-100	95-100	25-40	8-15
	6-60	Silt loam---------	CL, ML	A-4, A-6	0	100	100	95-100	95-100	25-40	8-15
SaB*:											
Sarpy------------	0-6	Fine sand---------	SM, SP-SM, SP	A-2-4, A-3	0	100	100	60-80	2-15	---	NP
	6-60	Fine sand, loamy fine sand, sand.	SM, SP, SP-SM	A-2-4, A-3	0	100	100	60-80	2-35	---	NP
Haynie-----------	0-60	Very fine sandy loam.	CL-ML, CL, ML	A-4, A-6	0	100	100	85-100	70-100	25-35	5-15
Sh, ShC, ShC2, ShD2------------- Sharpsburg	0-12	Silty clay loam	CL, CH	A-7, A-6	0	100	100	100	95-100	35-55	15-32
	12-44	Silty clay loam, silty clay.	CH, CL	A-7, A-6	0	100	100	100	95-100	35-60	20-35
	44-60	Silty clay loam	CL	A-7, A-6	0	100	100	100	95-100	35-50	18-30
SkF---------------- Shelby	0-12	Clay loam---------	CL	A-6, A-7-6	0	90-95	85-95	75-90	55-70	30-45	15-25
	12-40	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	35-45	15-25
	40-60	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25
SrE*:											
Shelby-----------	0-10	Clay loam---------	CL	A-6, A-7-6	0	90-95	85-95	75-90	55-70	30-45	15-25
	10-42	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	35-45	15-25
	42-60	Clay loam---------	CL	A-6, A-7	0-5	90-95	85-95	75-90	55-70	30-45	15-25

See footnote at end of table.

TABLE 14.--ENGINEERING INDEX PROPERTIES--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
SrE*:											
Burchard---------	0-8	Clay loam---------	CL	A-6, A-7	0-5	95-100	95-100	85-95	60-80	30-45	14-24
	8-30	Clay loam---------	CL	A-6, A-7	0-5	95-100	90-100	85-95	65-80	35-50	20-30
	30-60	Clay loam---------	CL	A-6, A-7	0-5	95-100	90-100	85-95	60-80	30-45	15-30
StF--------------- Steinauer	0-5	Clay loam---------	CL	A-6, A-7	0-5	95-100	90-100	80-100	55-90	30-45	12-25
	5-18	Clay loam---------	CL	A-6, A-7	0-5	95-100	95-100	85-100	60-90	30-50	12-30
	18-60	Loam, clay loam	CL	A-6, A-7	0-5	95-100	95-100	85-100	60-75	20-45	10-26
Wa---------------- Wabash	0-10	Silty clay--------	CH	A-7	0	100	100	100	95-100	50-75	30-50
	10-60	Silty clay, clay	CH	A-7	0	100	100	100	95-100	52-78	30-55
Wt---------------- Wymore	0-10	Silty clay loam	CH, MH	A-6, A-7	0	100	100	95-100	95-100	50-60	30-40
	10-40	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	40-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
WtC2-------------- Wymore	0-6	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	50-60	30-40
	6-36	Silty clay--------	CH	A-7	0	100	100	95-100	95-100	55-70	30-42
	36-60	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-100	35-55	20-35
Zh---------------- Zoe	0-8	Silty clay loam	CL	A-6, A-7, A-4	0	100	100	90-100	70-95	25-45	8-25
	8-24	Silty clay loam, silty clay.	CL, CH	A-6, A-7	0	100	100	95-100	85-95	35-60	15-35
	24-60	Silty clay--------	CH	A-7	0	100	100	95-100	90-95	50-70	25-40
Zo---------------- Zook	0-25	Silty clay loam	CH, CL, MH	A-7	0	100	100	95-100	95-100	40-55	15-30
	25-80	Silty clay, silty clay loam.	CH	A-7	0	100	100	95-100	95-100	60-85	35-55

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS

[The symbol < means less than; > means more than. Entries under "Erosion factors--T" apply to the entire profile. Entries under "Wind erodibility group" and "Organic matter" apply only to the surface layer. Absence of an entry indicates that data were not available or were not estimated]

Soil name and map symbol	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
Ab----------------	0-9	45-60	1.35-1.40	<0.2	0.11-0.13	7.4-8.4	<2	High------	0.28	5	4	2-3
Albaton	9-60	50-60	1.35-1.45	<0.06	0.11-0.13	7.4-8.4	<2	High------	0.28			
Co----------------	0-52	27-32	1.28-1.32	0.2-0.6	0.18-0.23	5.6-7.3	<2	Moderate	0.28	5	7	5-7
Colo	52-60	30-35	1.35-1.45	0.2-0.6	0.18-0.20	6.1-7.3	<2	Moderate	0.28			
DcD---------------	0-12	12-18	1.50-1.55	2.0-6.0	0.15-0.17	5.6-6.5	<2	Low-------	0.20	5	3	1-2
Dickinson	12-38	10-15	1.45-1.55	2.0-6.0	0.15-0.17	5.6-6.5	<2	Low-------	0.20			
	38-60	5-10	1.55-1.65	6.0-20	0.08-0.10	5.6-6.5	<2	Low-------	0.20			
DcF---------------	0-10	12-18	1.50-1.55	2.0-6.0	0.15-0.17	5.6-6.5	<2	Low-------	0.20	5	3	1-2
Dickinson	10-24	10-24	1.45-1.55	2.0-6.0	0.12-0.15	5.6-6.5	<2	Low-------	0.20			
	24-32	5-10	1.55-1.65	6.0-20	0.08-0.10	5.6-6.5	<2	Low-------	0.20			
	32-60	5-10	1.60-1.70	6.0-20	0.02-0.04	5.6-6.5	<2	Low-------	0.15			
Ha----------------	0-7	15-25	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37	5	4L	2-3
Haynie	7-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low-------	0.37			
Ju, JuC-----------	0-34	25-32	1.30-1.35	0.6-2.0	0.21-0.23	6.1-7.3	<2	Moderate	0.28	5	6	4-5
Judson	34-60	30-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	0.43			
Ke----------------	0-42	26-30	1.25-1.35	0.6-2.0	0.22-0.24	6.1-7.3	<2	Moderate	0.32	5	6	5-6
Kennebec	42-60	24-38	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
KnB*:												
Kennebec---------	0-37	26-30	1.25-1.35	0.6-2.0	0.22-0.24	6.1-7.3	<2	Moderate	0.32	5	6	5-6
	37-60	24-38	1.35-1.40	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
Nodaway----------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
KpF*:												
Kipson-----------	0-15	15-27	1.30-1.40	0.6-2.0	0.21-0.24	7.4-8.4	<2	Low-------	0.32	2	4L	2-3
	15-20	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
	20-60	---	---	---	---	---	---	----------	----			
Benfield---------	0-7	20-35	1.30-1.40	0.2-2.0	0.21-0.24	6.1-7.8	<2	Moderate	0.37	4	7	2-3
	7-36	35-45	1.35-1.45	0.06-0.2	0.18-0.22	6.6-8.4	<2	High------	0.37			
	36-60	---	---	---	---	---	---	----------	----			
MaD, MaD2, MaF---	0-7	17-23	1.20-1.30	0.6-2.0	0.22-0.24	5.6-6.5	<2	Low-------	0.32	5	5	1-3
Malcolm	7-28	24-35	1.30-1.40	0.6-2.0	0.18-0.22	5.6-6.5	<2	Moderate	0.43			
	28-60	12-23	1.20-1.30	0.6-2.0	0.17-0.22	5.6-6.5	<2	Low-------	0.43			
MhC, MhD2--------	0-7	27-32	1.25-1.30	0.6-2.0	0.21-0.23	5.6-6.5	<2	Moderate	0.32	5	7	2-4
Marshall	7-46	27-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-6.5	<2	Moderate	0.43			
	46-60	22-30	1.30-1.40	0.6-2.0	0.18-0.20	6.6-7.3	<2	Moderate	0.43			
MkE*:												
Marshall---------	0-10	25-27	1.25-1300	0.6-2.0	0.21-0.23	5.6-7.3	<2	Low-------	0.32	5	6	3-4
	10-40	27-35	1.30-1.35	0.6-2.0	0.18-0.20	5.6-7.3	<2	Moderate	0.43			
	40-60	22-27	1.30-1.40	0.6-2.0	0.18-0.20	6.6-7.3	<2	Moderate	0.43			
Ponca------------	0-10	23-32	1.10-1.30	0.6-2.0	0.21-0.23	6.1-7.3	<2	Moderate	0.32	5	6	2-4
	10-25	22-32	1.20-1.40	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	0.43			
	25-60	16-30	1.20-1.40	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.43			
MmC---------------	0-10	27-40	1.40-1.50	0.2-0.6	0.17-0.23	5.6-6.5	<2	Moderate	0.37	4	6	2-3
Mayberry	10-60	40-50	1.50-1.70	0.06-0.2	0.10-0.11	6.1-7.3	<2	High------	0.37			
	60-80	18-45	1.40-1.50	0.06-0.2	0.09-0.16	6.1-7.3	<2	Moderate	0.37			
MoC---------------	0-12	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
Monona	12-36	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	36-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate	0.43			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea- bility	Available water capacity	Soil reaction	Salinity	Shrink- swell potential	Erosion factors K	Erosion factors T	Wind erodi- bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
MoF------------- Monona	0-14	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	14-36	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	36-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate	0.43			
MpG*:												
Monona----------	0-5	20-27	1.25-1.30	0.6-2.0	0.22-0.24	5.6-7.3	<2	Moderate	0.32	5	6	3-4
	5-30	24-28	1.30-1.35	0.6-2.0	0.20-0.22	6.1-7.3	<2	Moderate	0.43			
	30-60	18-24	1.35-1.40	0.6-2.0	0.20-0.22	6.6-7.8	<2	Moderate	0.43			
Shelby----------	0-10	27-35	1.50-1.55	0.2-0.6	0.16-0.18	5.6-6.5	<2	Moderate	0.28	5	6	2-3
	10-40	30-35	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.8	<2	Moderate	0.28			
	40-60	30-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37			
Kipson----------	0-13	15-27	1.30-1.40	0.6-2.0	0.21-0.24	7.4-8.4	<2	Low-------	0.32	2	4L	2-3
	13-20	18-35	1.35-1.50	0.6-2.0	0.15-0.20	7.9-8.4	<2	Moderate	0.32			
	20-60	---	---	---	---	---	---	----------	----			
MrD------------- Morrill	0-10	15-30	1.30-1.40	0.6-2.0	0.17-0.21	5.6-6.5	<2	Low-------	0.28	5	6	2-3
	10-48	25-35	1.35-1.45	0.2-0.6	0.15-0.19	5.6-6.5	<2	Moderate	0.28			
	48-60	10-30	1.40-1.55	0.6-2.0	0.15-0.18	5.6-7.3	<2	Low-------	0.37			
MsC3*:												
Morrill---------	0-7	15-30	1.30-1.40	0.6-2.0	0.14-0.21	5.6-6.5	<2	Low-------	0.28	5	6	1-4
	7-43	25-35	1.35-1.45	0.6-2.0	0.15-0.19	5.6-6.5	<2	Moderate	0.28			
	43-60	10-30	1.40-1.55	0.6-2.0	0.15-0.18	5.6-7.3	<2	Low-------	0.37			
Mayberry--------	0-5	40-46	1.40-1.50	0.06-0.2	0.12-0.14	5.6-6.5	<2	High------	0.37	4	4	1-3
	5-40	40-50	1.50-1.70	0.06-0.2	0.10-0.11	6.1-7.3	<2	High------	0.37			
	40-80	18-45	1.40-1.50	0.06-0.2	0.09-0.16	6.1-7.3	<2	Moderate	0.37			
Nc-------------- Nodaway	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
Nd*:												
Nodaway---------	0-60	18-28	1.25-1.35	0.6-2.0	0.20-0.23	6.1-7.3	<2	Moderate	0.37	5	6	2-3
Colo------------	0-54	27-32	1.28-1.32	0.6-2.0	0.18-0.23	5.6-7.3	<2	Moderate	0.28	5	7	5-7
	54-60	30-35	1.35-1.45	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	0.28			
Oc-------------- Onawa	0-7	15-22	1.20-1.25	0.6-2.0	0.22-0.24	7.4-8.4	<2	Low-------	0.32	5	4L	2-3
	7-28	50-60	1.30-1.40	0.2-0.6	0.12-0.14	7.4-8.4	<2	High------	0.32			
	28-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low-------	0.43			
On-------------- Onawa	0-6	38-55	1.30-1.35	0.2-0.6	0.12-0.14	7.4-8.4	<2	High------	0.32	5	4	2-3
	6-21	50-60	1.30-1.40	0.2-0.6	0.12-0.14	7.4-8.4	<2	High------	0.32			
	21-60	12-18	1.40-1.50	0.6-6.0	0.20-0.22	7.4-8.4	<2	Low-------	0.43			
PaC, PaD-------- Pawnee	0-12	30-38	1.40-1.50	0.2-0.6	0.17-0.19	5.6-6.5	<2	Moderate	0.37	4	6	3-4
	12-56	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-7.8	<2	High------	0.37			
	56-60	25-35	1.40-1.60	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
PbC2, PbD2------ Pawnee	0-7	40-46	1.40-1.50	0.06-0.2	0.09-0.11	5.6-6.5	<2	High------	0.37	4	4	1-3
	7-45	40-50	1.50-1.70	0.06-0.2	0.09-0.11	6.1-7.8	<2	High------	0.37			
	45-60	25-40	1.40-1.60	0.06-0.2	0.14-0.16	7.4-8.4	<2	High------	0.37			
Pf*. Pits												
PwD2*, PwE2*:												
Ponca-----------	0-8	22-27	1.10-1.30	0.6-2.0	0.21-0.23	6.1-7.3	<2	Moderate	0.32	5	6	1-3
	8-18	22-32	1.20-1.40	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	0.43			
	18-60	16-30	1.20-1.40	0.6-2.0	0.18-0.20	7.4-8.4	<2	Moderate	0.43			
Dow-------------	0-6	18-25	1.20-1.45	0.6-2.0	0.22-0.24	6.6-8.4	<2	Low-------	0.43	5	4L	.5-2
	6-60	18-25	1.30-1.45	0.6-2.0	0.20-0.22	7.9-8.4	<2	Low-------	0.43			
SaB*:												
Sarpy-----------	0-6	2-5	1.20-1.50	>6.0	0.05-0.09	6.6-8.4	<2	Low-------	0.15	5	1	<1
	6-60	2-5	1.20-1.50	>6.0	0.05-0.09	7.4-8.4	<2	Low-------	0.15			

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Soil name and map symbol	Depth	Clay	Moist bulk density	Permea-bility	Available water capacity	Soil reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodi-bility group	Organic matter
	In	Pct	G/cm3	In/hr	In/in	pH	Mmhos/cm					Pct
SaB*:												
Haynie----------	0-60	15-18	1.20-1.35	0.6-2.0	0.18-0.23	7.4-8.4	<2	Low--------	0.37	5	4L	1-3
Sh, ShC, ShC2, ShD2----------- Sharpsburg	0-12	28-34	1.30-1.35	0.6-2.0	0.21-0.23	5.6-6.5	<2	Moderate	0.32	5	7	2-4
	12-44	36-42	1.35-1.40	0.2-0.6	0.18-0.20	5.6-6.5	<2	High------	0.43			
	44-60	28-40	1.40-1.45	0.6-2.0	0.18-0.20	6.1-7.3	<2	Moderate	0.43			
SkF------------- Shelby	0-12	27-32	1.50-1.55	0.2-0.6	0.17-0.19	5.6-6.5	<2	Moderate	0.28	5	6	2-4
	12-40	30-38	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.3	<2	Moderate	0.28			
	40-60	27-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37			
SrE*:												
Shelby----------	0-10	27-32	1.50-1.55	0.2-0.6	0.17-0.19	5.6-6.5	<2	Moderate	0.28	5	6	2-4
	10-42	30-38	1.55-1.75	0.2-0.6	0.16-0.18	5.6-7.3	<2	Moderate	0.28			
	42-60	27-35	1.75-1.85	0.2-0.6	0.16-0.18	6.6-8.4	<2	Moderate	0.37			
Burchard--------	0-8	27-32	1.40-1.60	0.2-0.6	0.17-0.19	5.6-7.3	<2	Moderate	0.28	5	6	2-4
	8-30	27-38	1.40-1.60	0.2-0.6	0.15-0.17	6.1-8.4	<2	Moderate	0.28			
	30-60	27-35	1.40-1.60	0.2-0.6	0.14-0.16	7.4-8.4	<2	Moderate	0.28			
StF------------- Steinauer	0-5	27-32	1.30-1.60	0.2-0.6	0.17-0.19	7.4-8.4	<2	Moderate	0.32	5	4L	.5-2
	5-18	27-32	1.30-1.60	0.2-0.6	0.15-0.17	7.9-8.4	<2	Moderate	0.32			
	18-60	16-32	1.30-1.60	0.2-2.0	0.14-0.19	7.9-8.4	<2	Moderate	0.32			
Wa-------------- Wabash	0-10	40-46	1.25-1.45	<0.06	0.12-0.14	5.6-6.5	<2	Very high	0.28	5	4	2-4
	10-60	40-60	1.20-1.45	<0.06	0.08-0.12	6.1-7.8	<2	Very high	0.28			
Wt-------------- Wymore	0-10	30-40	1.15-1.20	0.2-0.6	0.21-0.23	5.6-6.5	<2	Moderate	0.37	4	7	2-4
	10-40	42-55	1.10-1.20	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	40-60	27-35	1.15-1.25	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
WtC2------------ Wymore	0-6	40-45	1.15-1.20	0.2-0.6	0.13-0.15	5.6-6.5	<2	High------	0.37	4	4	2-4
	6-36	42-55	1.20-1.40	0.06-0.2	0.11-0.14	5.6-7.3	<2	High------	0.37			
	36-60	27-35	1.30-1.45	0.2-0.6	0.18-0.20	6.6-7.3	<2	High------	0.37			
Zh-------------- Zoe	0-8	34-40	1.10-1.30	0.2-0.6	0.17-0.23	6.1-7.8	<4	Moderate	0.32	5	4	1-3
	8-24	36-45	1.20-1.30	<0.06	0.11-0.20	6.1-7.8	4-8	High------	0.32			
	24-60	40-50	1.20-1.30	0.06-0.2	0.10-0.13	7.4-9.0	2-4	High------	0.32			
Zo-------------- Zook	0-25	28-38	1.30-1.35	0.2-0.6	0.21-0.23	5.6-7.3	<2	High------	0.28	5	7	5-7
	25-80	40-50	1.30-1.45	0.06-0.2	0.11-0.13	5.6-7.8	<2	High------	0.28			

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

["Flooding" and "water table" and terms such as "rare," "brief," "apparent," and "perched" are explained in the text. The symbol > means more than. Absence of an entry indicates that the feature is not a concern]

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ab----------------- Albaton	D	Occasional	Brief-----	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	Moderate	High-----	Low.
Co----------------- Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High-----	High-----	Moderate.
DcD, DcF----------- Dickinson	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
Ha----------------- Haynie	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High-----	Low------	Low.
Ju, JuC------------ Judson	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
Ke----------------- Kennebec	B	Rare---------	---	---	4.0-6.0	Perched	Nov-Jul	>60	---	High-----	Moderate	Low.
KnB*:												
Kennebec----------	B	Rare---------	---	---	4.0-6.0	Perched	Nov-Jul	>60	---	High-----	Moderate	Low.
Nodaway-----------	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High-----	Moderate	Low.
KpF*:												
Kipson------------	D	None---------	---	---	>6.0	---	---	7-20	Soft	Moderate	Low------	Low.
Benfield----------	C	None---------	---	---	>6.0	---	---	20-40	Soft	Moderate	High-----	Low.
MaD, MaD2, MaF---- Malcolm	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
MhC, MhD2--------- Marshall	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
MkE*:												
Marshall----------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
Ponca-------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Low.
MmC---------------- Mayberry	D	None---------	---	---	1.0-3.0	Perched	Mar-May	>60	---	High-----	High-----	Low.
MoC, MoF----------- Monona	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
MpG*:												
Monona------------	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Low------	Low.
Shelby------------	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months	High water table: Depth	High water table: Kind	High water table: Months	Bedrock: Depth	Bedrock: Hardness	Potential frost action	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete
					Ft			In				
MpG*:												
Kipson	D	None	---	---	>6.0	---	---	7-20	Soft	Moderate	Low	Low.
MrD Morrill	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
MsC3*:												
Morrill	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Mayberry	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.
Nc Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
Nd*:												
Nodaway	B	Occasional	Very brief to brief.	Feb-Nov	3.0-5.0	Apparent	Apr-Jul	>60	---	High	Moderate	Low.
Colo	B/D	Occasional	Very brief to long.	Feb-Nov	1.0-3.0	Apparent	Nov-Jul	>60	---	High	High	Moderate.
Oc, On Onawa	D	Occasional	Brief	Feb-Nov	3.0-4.0	Apparent	Nov-Jul	>60	---	High	High	Low.
PaC, PaD, PbC2, PbD2 Pawnee	D	None	---	---	1.0-3.0	Perched	Mar-May	>60	---	High	High	Low.
Pf*. Pits												
PwD2*, PwE2*:												
Ponca	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
Dow	B	None	---	---	>6.0	---	---	>60	---	High	Low	Low.
SaB*:												
Sarpy	A	Occasional	Brief to long.	Nov-Jun	>6.0	---	---	>60	---	Low	Low	Low.
Haynie	B	Occasional	Very brief	Feb-Nov	>6.0	---	---	>60	---	High	Low	Low.
Sn, ShC, ShC2, ShD2 Sharpsburg	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
SkF Snelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
SrE*:												
Shelby	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Burchard	B	None	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro- logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
StF---------------- Steinauer	B	None----------	---	---	>6.0	---	---	>60	---	Moderate	Hign------	Low.
Wa----------------- Wabash	D	Occasional	Brief to long.	Nov-May	0-1.0	Perched	Nov-May	>60	---	Moderate	High------	Moderate.
Wt, WtC2----------- Wymore	D	None----------	---	---	1.0-3.0	Perched	Mar-Apr	>60	---	High------	High------	Moderate.
Zh----------------- Zoe	D	Occasional	Brief------	Mar-Jun	1.0-3.0	Perched	Nov-May	>60	---	High------	High------	High.
Zo----------------- Zook	C/D	Occasional	Brief to long.	Feb-Nov	1.0-3.0	Perched	Nov-May	>60	---	High------	High------	Moderate.

* See description of the map unit for composition and behavior characteristics of the map unit.

TABLE 17.--ENGINEERING INDEX TEST DATA

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution										Liquid limit	Plasticity index	Specific gravity
			Percentage passing sieve--							Percentage smaller than--					
	AASHTO	Unified	2 inch	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm			
													Pct		G/cc
Dickinson fsl:[1] (S76NE-131-001)															
A1--------0 to 12	A-2 (04)	SM	100	100	100	99	99	96	34	29	11	9	21	1	2.61
B3-------24 to 38	A-2 (04)	SM	100	100	100	100	100	98	28	23	13	11	18	NP	2.62
C--------38 to 60	A-2 (04)	SM	100	100	99	99	99	97	27	20	11	10	18	NP	2.62
Kipson cn-sil:[2] (S77NE-131-003)															
AC--------8 to 15	A-6 (10)	CL	100	99	96	94	92	88	86	80	36	23	40	16	2.71
C1-------15 to 36	A-6 (08)	CL	100	100	100	99	96	93	91	85	34	21	33	11	2.72
Malcolm sil:[3] (S77NE-131-006)															
A1--------0 to 7	A-7-5(12)	ML	100	100	100	100	100	99	91	82	24	17	46	16	2.58
B2t-------7 to 28	A-7-6(17)	CH	100	100	100	100	100	100	97	94	39	33	53	26	2.66
C--------28 to [illegible]0	A-4 (08)	ML	100	100	100	100	100	100	98	85	9	6	27	2	2.66
Marshall sicl:[4] (S77NE-131-008)															
Ap--------0 to 7	A-6 (10)	CL	100	100	100	100	100	100	99	95	32	27	39	14	2.[illegible]2
B21------12 to 36	A-7-6(16)	CH	100	100	100	100	100	100	99	96	39	32	52	25	2.68
C--------46 to 70	A-7-6(16)	CL	100	100	100	100	100	100	100	96	35	30	49	25	2.73
Nodaway sil:[5] (S77NE-131-005)															
Ap--------0 to 6	A-4 (08)	ML	100	100	100	100	100	100	96	90	24	18	34	10	2.61
C---------6 to 72	A-6 (09)	CL	100	100	100	100	100	100	98	94	28	22	37	13	2.62
Pawnee cl:[6] (S77NE-131-002)															
A1--------0 to 12	A-6 (10)	CL	100	100	100	100	100	96	82	77	31	27	39	16	2.61
B21t-----12 to 42	A-7-6(21)	CH	100	100	100	99	98	92	80	77	46	42	58	34	2.68
B3-------42 to 80	A-7-6(17)	CL	100	100	100	100	99	92	75	72	43	35	49	28	2.69
Sharpsburg sicl:[7] (S77NE-131-009)															
A1--------0 to 1	A-6 (10)	CL	100	100	100	100	100	100	99	96	33	26	40	15	2.64
B21t-----17 to 44	A-7-6(21)	CH	100	100	100	100	100	100	99	94	43	36	60	32	2.69
C--------56 to 75	A-7-6(12)	CL	100	100	100	100	100	100	100	96	40	31	43	19	2.71
Steinauer cl:[8] (S77NE-131-001)															
A1--------0 to 5	A-6 (06)	CL	100	100	97	95	91	84	57	51	22	15	36	13	2.62
B1--------5 to 18	A-7-6(11)	CL	100	100	99	98	95	87	68	63	33	25	42	19	2.69
C--------18 to 45	A-7-6(14)	CL	100	100	99	98	96	89	71	65	36	29	44	24	2.69

See footnotes at end of table.

TABLE 17.--ENGINEERING INDEX TEST DATA--Continued

Soil name, report number, horizon, and depth in inches	Classification		Grain size distribution										Liquid limit	Plasticity index	Specific gravity
			Percentage passing sieve--							Percentage smaller than--					
	AASHTO	Unified	2 inch	3/4 inch	3/8 inch	No. 4	No. 10	No. 40	No. 200	.05 mm	.005 mm	.002 mm			
													Pct		G/cc
Wymore sic:[9] (S77NE-131-007)															
Ap--------0 to 6	A-7-6(20)	CH	100	100	100	100	100	100	99	98	49	43	58	30	2.63
B21-------6 to 28	A-7-6(21)	CH	100	100	100	100	100	100	99	98	49	42	61	33	2.69
C--------36 to 60	A-7-6(13)	CL	100	100	100	100	100	100	100	98	36	31	44	21	2.69
Zook sicl:[10] (S77NE-131-004)															
A1--------0 to 25	A-7-6(12)	CL	100	100	100	100	100	100	99	94	38	29	44	19	2.60
A13------25 to 84	A-7-5(30)	CH	100	100	100	99	99	99	98	97	64	54	76	46	2.70

[1]Dickinson fine sandy loam: 845 feet north and 580 feet west of the center of sec. 25, T. 7 N., R. 9 E.

[2]Kipson channery silt loam: 1,050 feet south and 150 feet east of the northwest corner of sec. 19, T. 8 N., R. 11 E.

[3]Malcolm silt loam: 1,670 feet north and 125 feet east of the southwest corner of sec. 14, T. 7 N., R. 10 E.

[4]Marshall silty clay loam: 230 feet south and 240 feet west of the northeast corner of sec. 11, T. 9 N., R. 13 E.

[5]Nodaway silt loam: 1,150 feet west and 150 feet north of the southeast corner of sec. 36, T. 9 N., R. 10 E.

[6]Pawnee clay loam: 2,450 feet west and 200 feet north of the southeast corner of sec. 4, T. 8 N., R. 9 E.

[7]Sharpsburg silty clay loam: 2,400 feet south and 200 feet east of the northwest corner of sec. 9, T. 9 N., R. 13 E.

[8]Steinauer clay loam: 1,200 feet north and 420 feet east of the southwest corner of sec. 22, T. 8 N., R. 9 E.

[9]Wymore silty clay: 1,975 feet east and 185 feet north of the southwest corner of sec. 19, T. 9 N., R. 11 E.

[10]Zook silty clay loam: 2,740 feet north and 150 feet west of the southeast corner of sec. 22, T. 7 N., R. 12 E.

TABLE 18.--CLASSIFICATION OF THE SOILS

Soil name	Family or higher taxonomic class
Albaton	Fine, montmorillonitic (calcareous), mesic Vertic Fluvaquents
*Benfield	Fine, mixed, mesic Udic Argiustolls
Burchard	Fine-loamy, mixed, mesic Typic Argiudolls
Colo	Fine-silty, mixed, mesic Cumulic Haplaquolls
Dickinson	Coarse-loamy, mixed, mesic Typic Hapludolls
Dow	Fine-silty, mixed (calcareous), mesic Typic Udorthents
Haynie	Coarse-silty, mixed (calcareous), mesic Mollic Udifluvents
Judson	Fine-silty, mixed, mesic Cumulic Hapludolls
Kennebec	Fine-silty, mixed, mesic Cumulic Hapludolls
*Kipson	Loamy, mixed, mesic, shallow Udorthentic Haplustolls
Malcolm	Fine-silty, mixed, mesic Typic Argiudolls
Marshall	Fine-silty, mixed, mesic Typic Hapludolls
Mayberry	Fine, montmorillonitic, mesic Aquic Argiudolls
Monona	Fine-silty, mixed, mesic Typic Hapludolls
Morrill	Fine-loamy, mixed, mesic Typic Argiudolls
Nodaway	Fine-silty, mixed, nonacid, mesic Mollic Udifluvents
Onawa	Clayey over loamy, montmorillonitic (calcareous), mesic Mollic Fluvaquents
Pawnee	Fine, montmorillonitic, mesic Aquic Argiudolls
Ponca	Fine-silty, mixed, mesic Typic Hapludolls
Sarpy	Mixed, mesic Typic Udipsamments
Sharpsburg	Fine, montmorillonitic, mesic Typic Argiudolls
Shelby	Fine-loamy, mixed, mesic Typic Argiudolls
Steinauer	Fine-loamy, mixed (calcareous), mesic Typic Udorthents
Wabash	Fine, montmorillonitic, mesic Vertic Haplaquolls
Wymore	Fine, montmorillonitic, mesic Aquic Argiudolls
Zoe	Fine, montmorillonitic, mesic Cumulic Haplaquolls
Zook	Fine, montmorillonitic, mesic Cumulic Haplaquolls

*The soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series.

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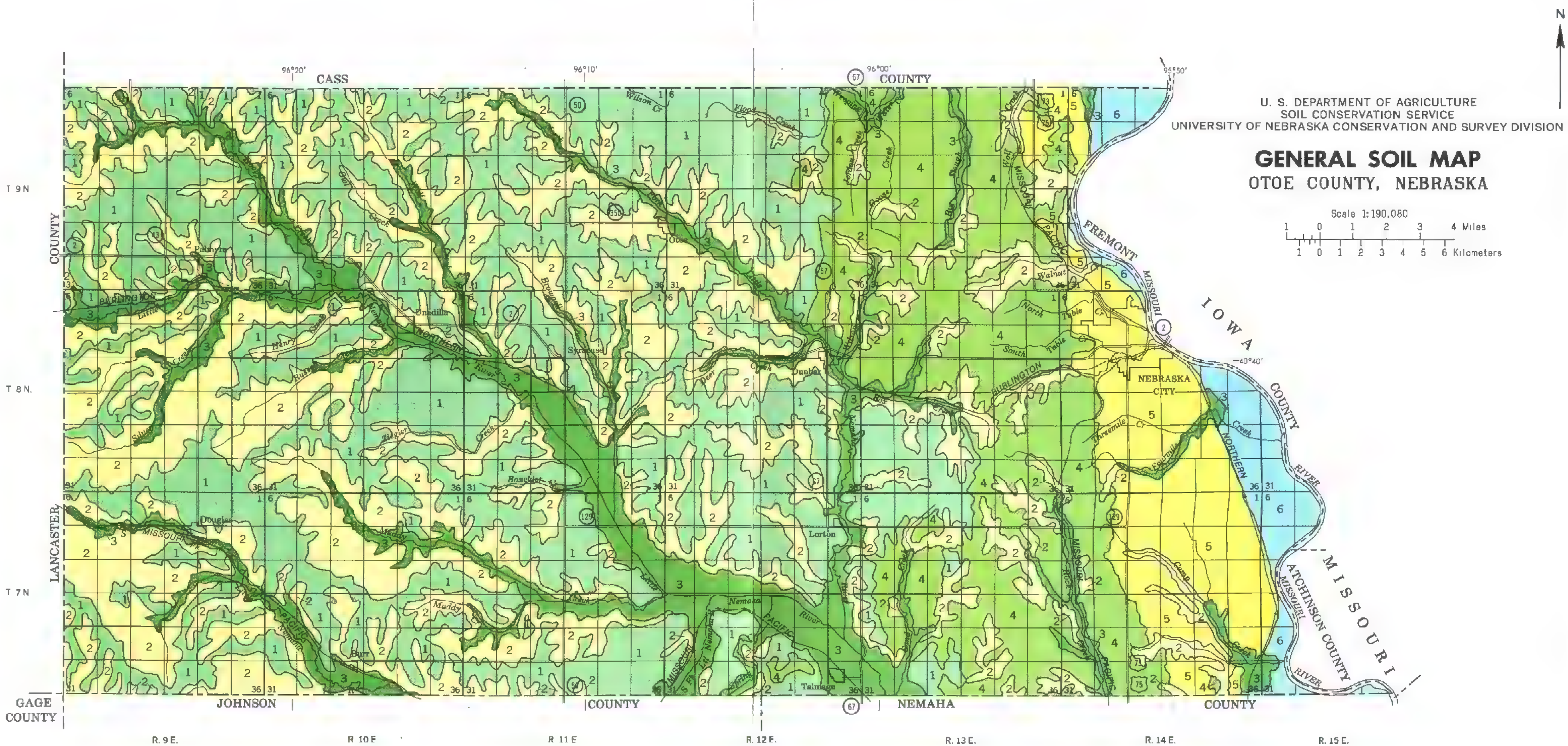


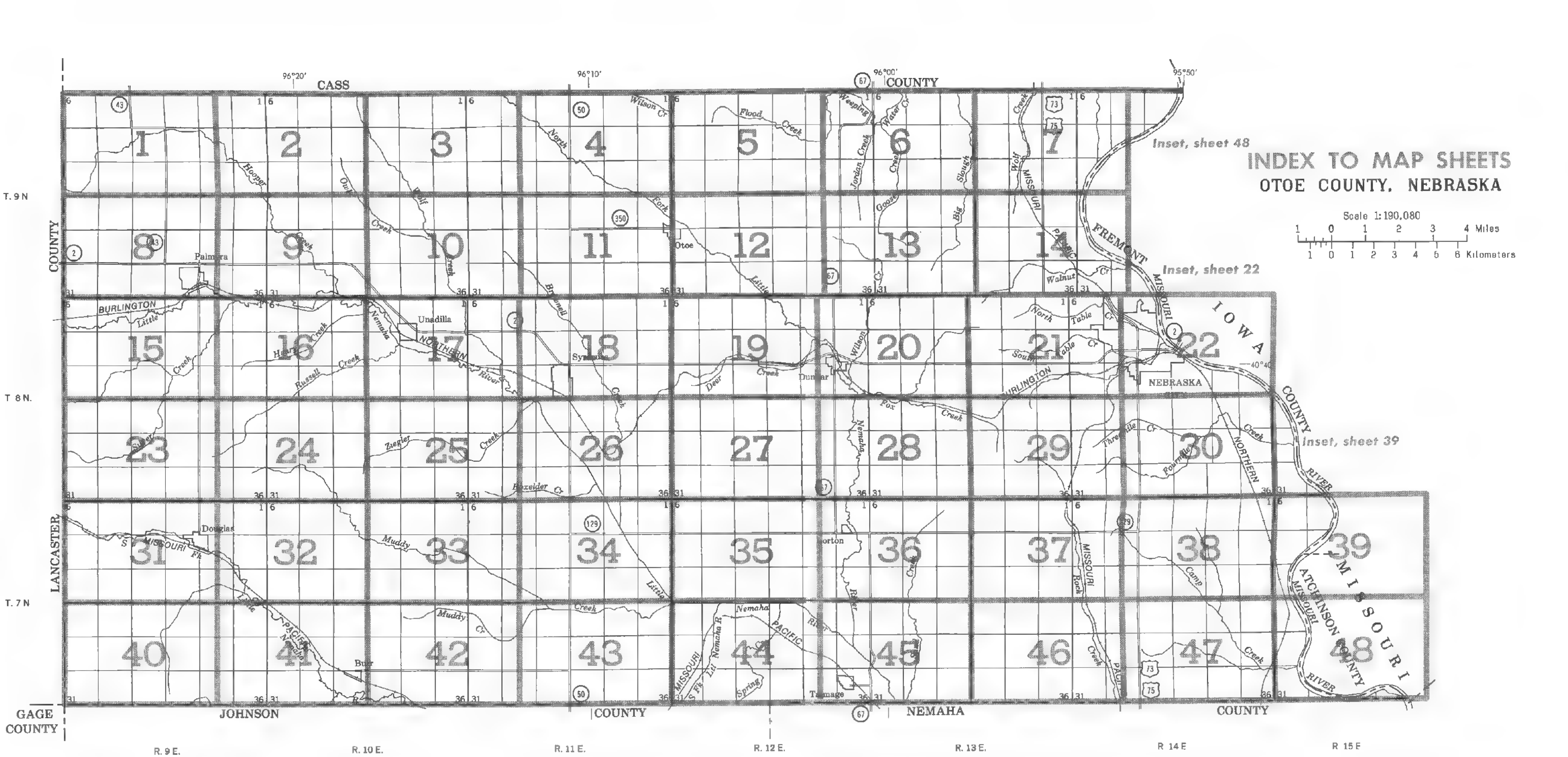
SOIL LEGEND*

1	Wymore association: Deep, nearly level and gently sloping, moderately well drained clayey and silty soils that formed in loess on uplands
2	Pawnee-Morrill-Shelby association: Deep, gently sloping to steep, moderately well drained to somewhat excessively drained clayey and loamy soils that formed in glacial deposits on uplands
3	Zook-Nodaway-Judson association: Deep, nearly level and gently sloping poorly drained, moderately well drained, and well drained silty soils that formed in alluvium and colluvium on bottom lands, foot slopes, and stream terraces
4	Sharpsburg association: Deep, nearly level to strongly sloping, moderately well drained silty soils that formed in loess on uplands
5	Marshall-Monona-Ponca association: Deep, gently sloping to very steep, well drained and somewhat excessively drained silty soils that formed in loess on uplands
6	Haynie-Onawa-Albaton association: Deep, nearly level, moderately well drained to poorly drained silty and clayey soils that formed in alluvium on bottom lands

*Texture terms refer to the surface layer of the major soils.

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

SOIL LEGEND

Map symbols consist of a combination of letters or of letters and numbers. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 indicates that the soil is eroded and 3 that it is severely eroded.

SYMBOL	NAME
Ab	Albaton silty clay, 0 to 1 percent slopes
Co	Colo silty clay loam, 0 to 1 percent slopes
DcD	Dickinson fine sandy loam, 6 to 11 percent slopes
DcF	Dickinson fine sandy loam, 11 to 20 percent slopes
Ha	Haynie silt loam, 0 to 2 percent slopes
Ju	Judson silt loam, 0 to 2 percent slopes
JuC	Judson silt loam, 2 to 6 percent slopes
Ke	Kennebec silt loam, 0 to 1 percent slopes
KnB	Kennebec-Nodaway silt loams, 0 to 4 percent slopes
KpF	Kipson-Benfield complex, 6 to 20 percent slopes
MaD	Malcolm silt loam, 5 to 11 percent slopes
MaD2	Malcolm silt loam, 5 to 11 percent slopes, eroded
MaF	Malcolm silt loam, 11 to 25 percent slopes
MhC	Marshall silty clay loam, 2 to 5 percent slopes
MhD2	Marshall silty clay loam, 5 to 11 percent slopes, eroded
MkE	Marshall-Ponca silt loams, 11 to 17 percent slopes
MmC	Mayberry clay loam, 3 to 9 percent slopes
MoC	Monona silt loam, 2 to 5 percent slopes
MoF	Monona silt loam, 17 to 30 percent slopes
MpG	Monona-Shelby-Kipson complex, 30 to 70 percent slopes
MrD	Morrill clay loam, 5 to 11 percent slopes
MsC3	Morrill-Mayberry complex, 3 to 9 percent slopes, severely eroded
Nc	Nodaway silt loam, 0 to 1 percent slopes
Nd	Nodaway-Colo complex, 0 to 2 percent slopes
Oc	Onawa silt loam, overwash, 0 to 1 percent slopes
On	Onawa silty clay, 0 to 1 percent slopes
PaC	Pawnee clay loam, 3 to 9 percent slopes
PaD	Pawnee clay loam, 9 to 12 percent slopes
PbC2	Pawnee clay, 3 to 9 percent slopes, eroded
PbD2	Pawnee clay, 9 to 12 percent slopes, eroded
Pf	Pits
PwD2	Ponca-Dow silt loams, 5 to 11 percent slopes, eroded
PwE2	Ponca-Dow silt loams, 11 to 17 percent slopes, eroded
SaB	Sarpy-Haynie complex, 0 to 3 percent slopes
Sh	Sharpsburg silty clay loam, 0 to 2 percent slopes
ShC	Sharpsburg silty clay loam, 2 to 5 percent slopes
ShC2	Sharpsburg silty clay loam, 2 to 5 percent slopes, eroded
ShD2	Sharpsburg silty clay loam, 5 to 11 percent slopes, eroded
SkF	Shelby clay loam, 15 to 30 percent slopes
SrE	Shelby and Burchard clay loams, 9 to 15 percent slopes
StF	Steinauer clay loam, 11 to 20 percent slopes
Wa	Wabash silty clay, 0 to 1 percent slopes
Wt	Wymore silty clay loam, 0 to 2 percent slopes
WtC2	Wymore silty clay, 2 to 7 percent slopes, eroded
Zh	Zoe silty clay loam, 0 to 1 percent slopes
Zo	Zook silty clay loam, 0 to 1 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — Ab; WtC2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

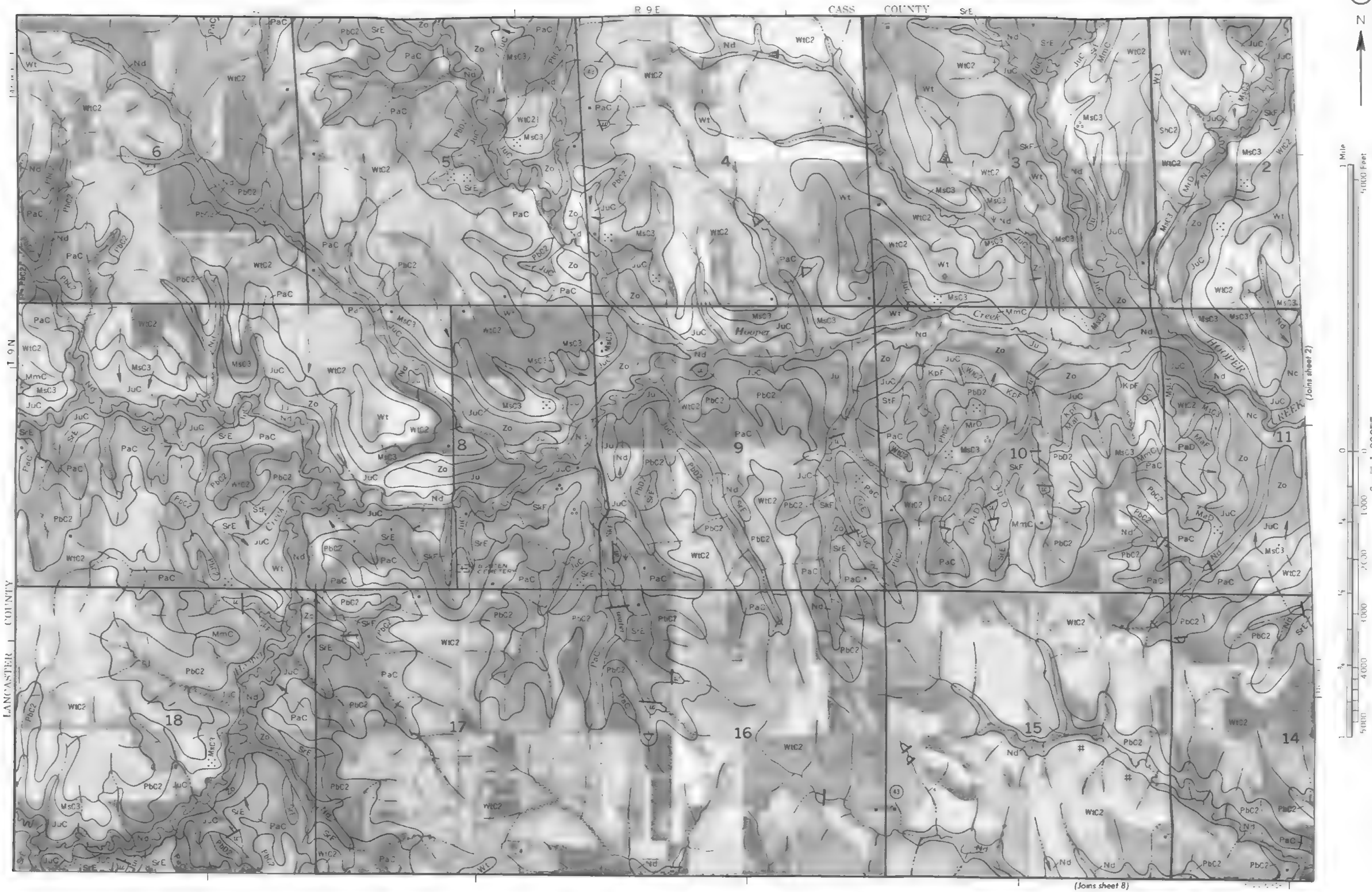
GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Glacial till spot


R 9 E
CASS COUNTY
T 9 N
LANCASTER COUNTY
N
Hooper Creek
HOOPER CREEK
(Joins sheet 2)
(Joins sheet 8)
1 Mile
5000 Feet
Scale 1:20000
6
5
4
3
2
7
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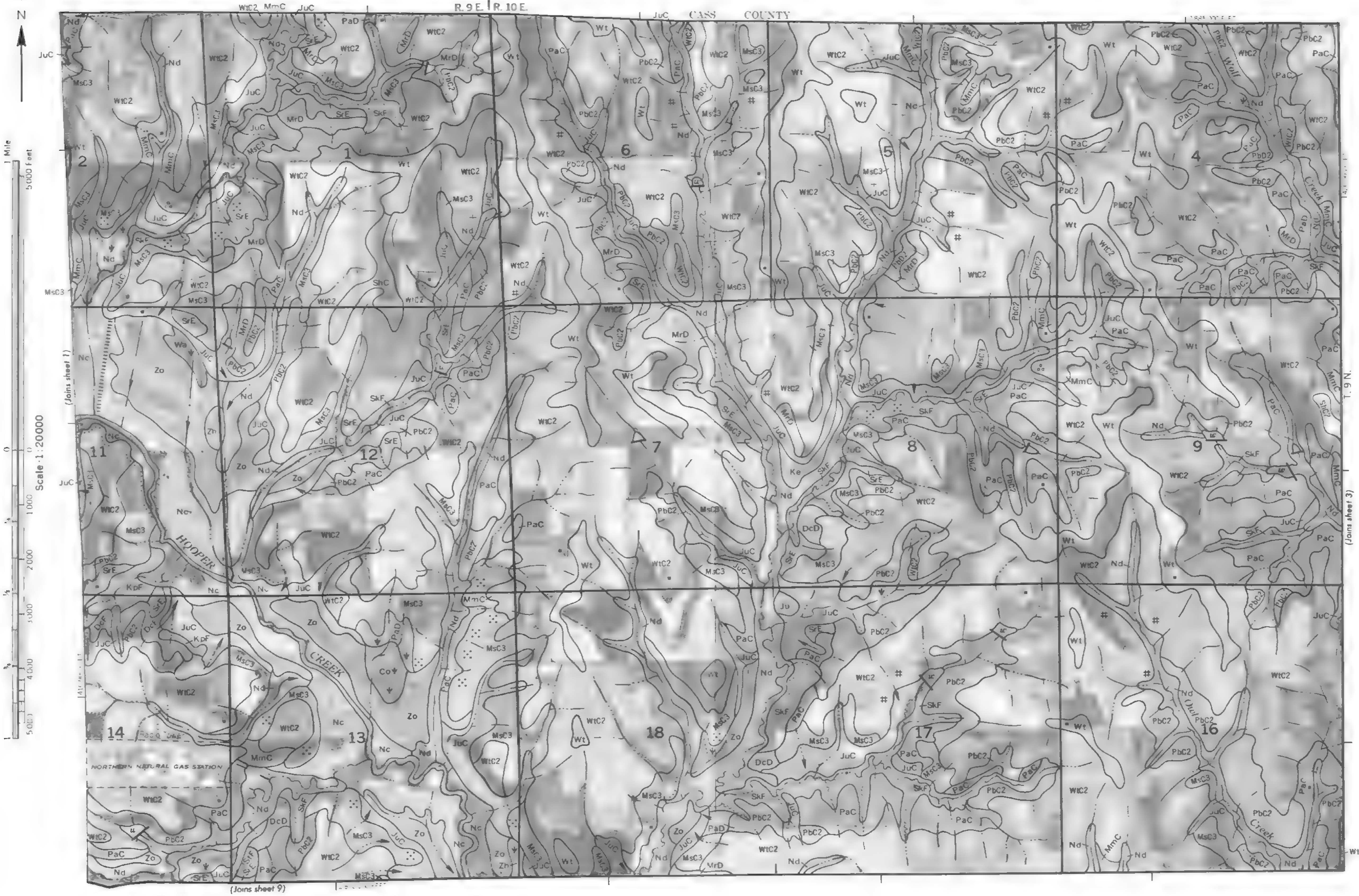
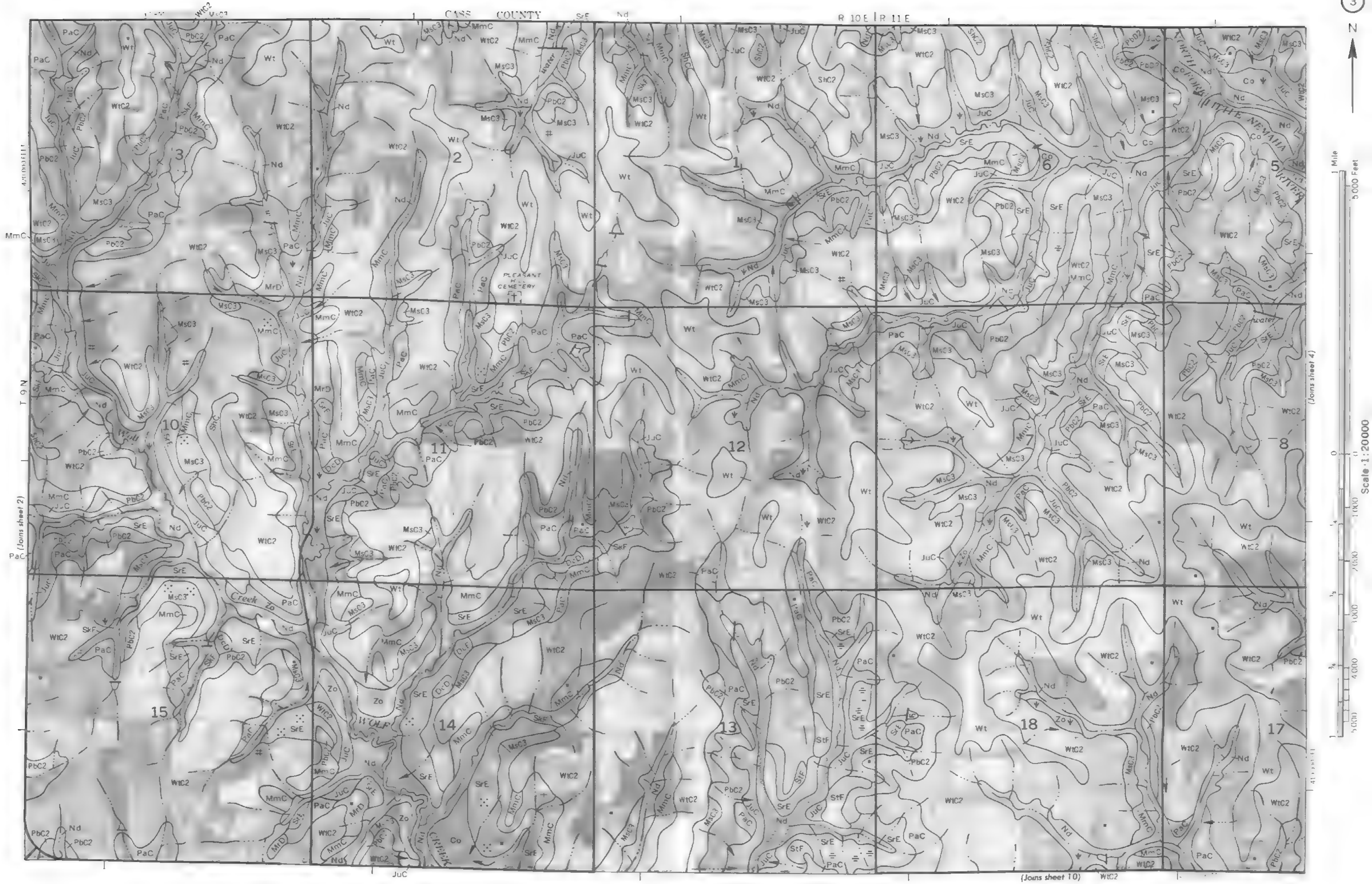
9
10
11
18
17
16
15
14

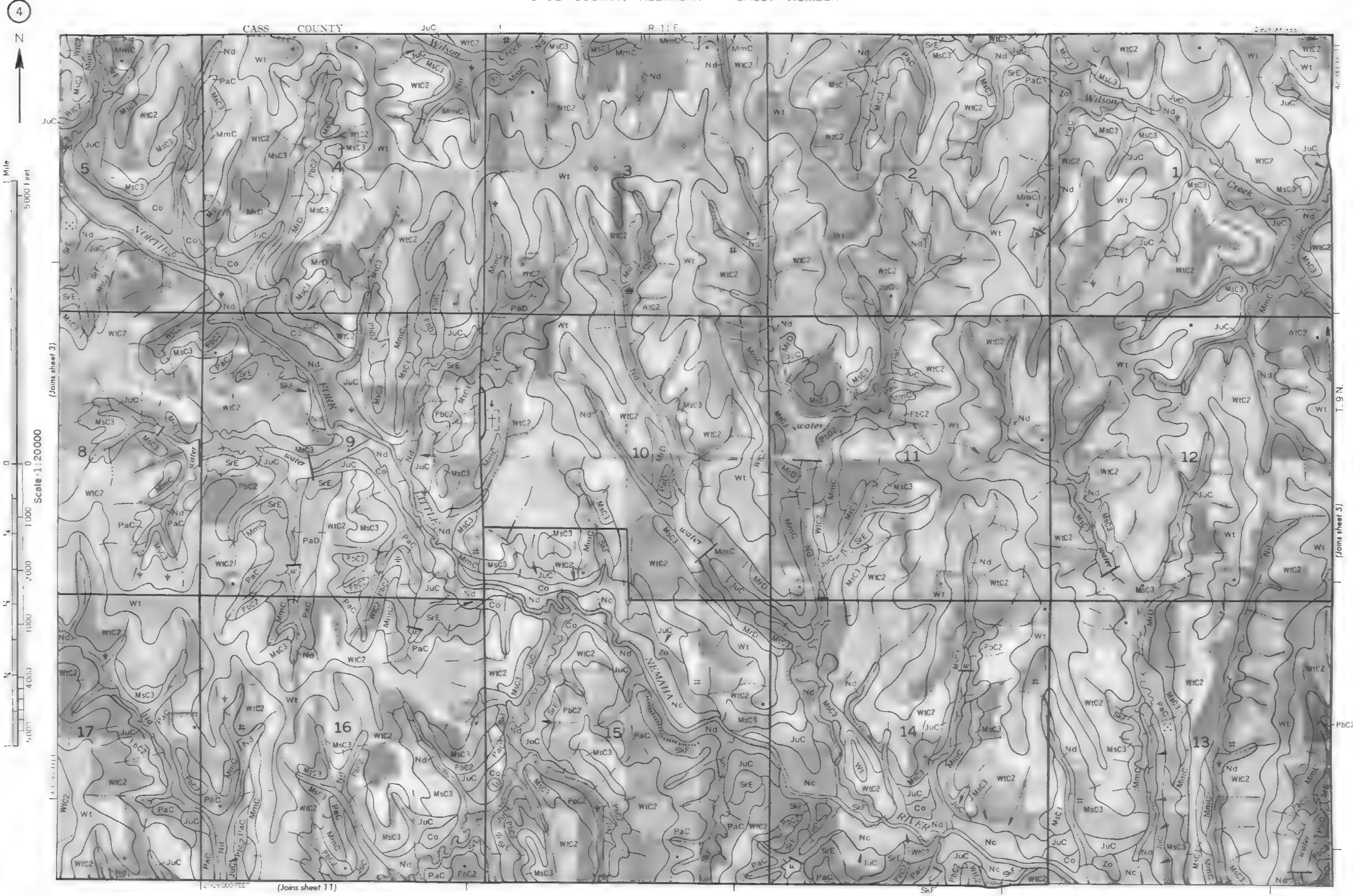
2

OTOE COUNTY, NEBRASKA — SHEET NUMBER 2

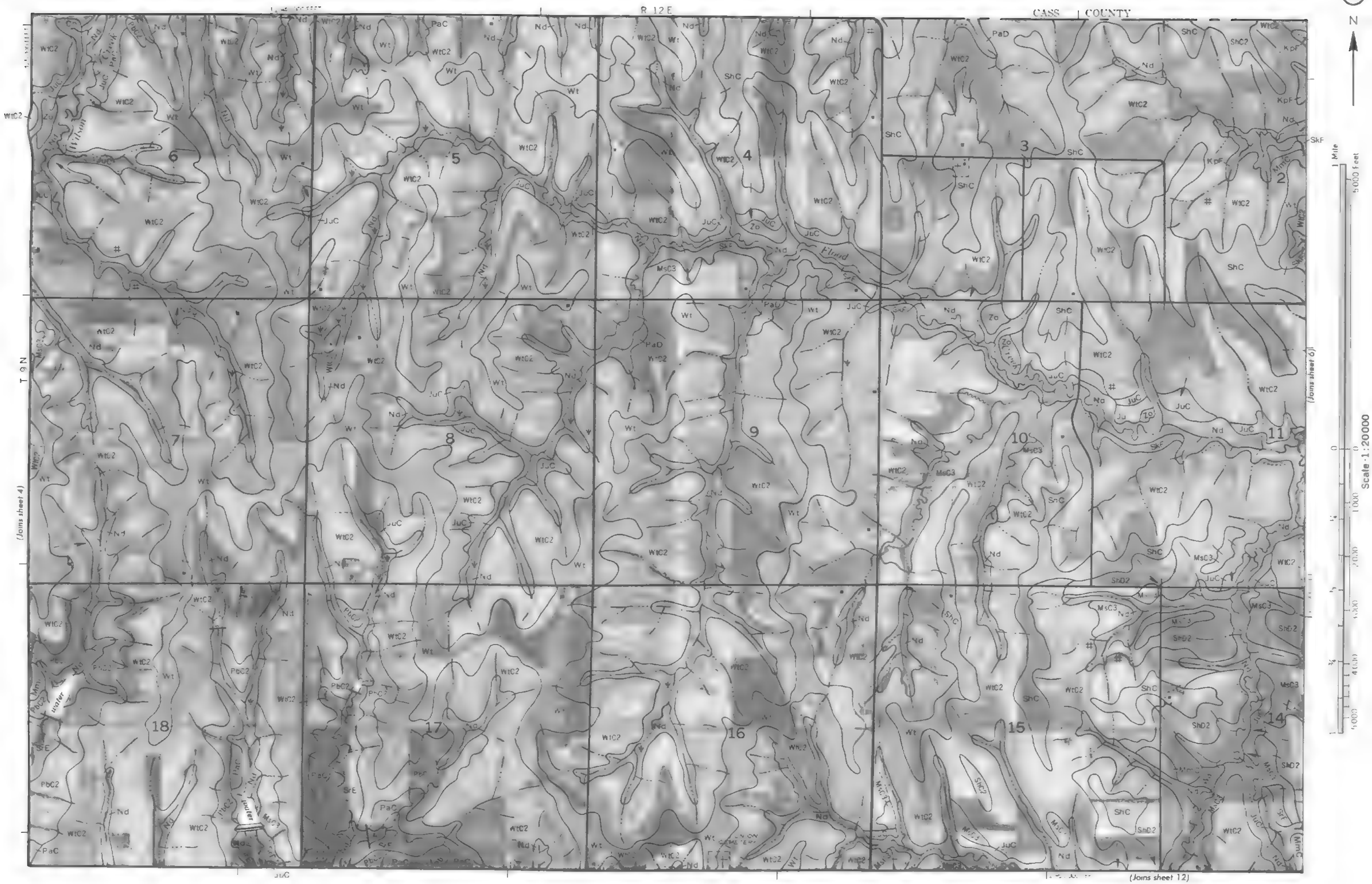


OTOE COUNTY, NEBRASKA NO. 2


3
N
CASS COUNTY
R 10 E | R 11 E
T 9 N
PLEASANT HILL CEMETERY
Wolf Creek
WOLF CREEK
NORTH FORK LITTLE NEMAHA RIVER
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 10)
Scale 1:20000
1 Mile
5000 Feet
OTOE COUNTY, NEBRASKA NO. 3


4
N
CASS COUNTY
R. 11 E.
T. 9 N.
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 11)
NORTH FORK
LITTLE NEMAHA RIVER
Wilson Creek
water
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

OTOE COUNTY, NEBRASKA — SHEET NUMBER 5




6
N
1 Mile
5000 Feet
Scale 1:20000
CASS COUNTY
R 12 E
R 13 E
T. 9 N.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 13)
South Branch
Weeping Water Creek
Big Slough
Jordan Creek
1
2
4
5
6
7
8
9
11
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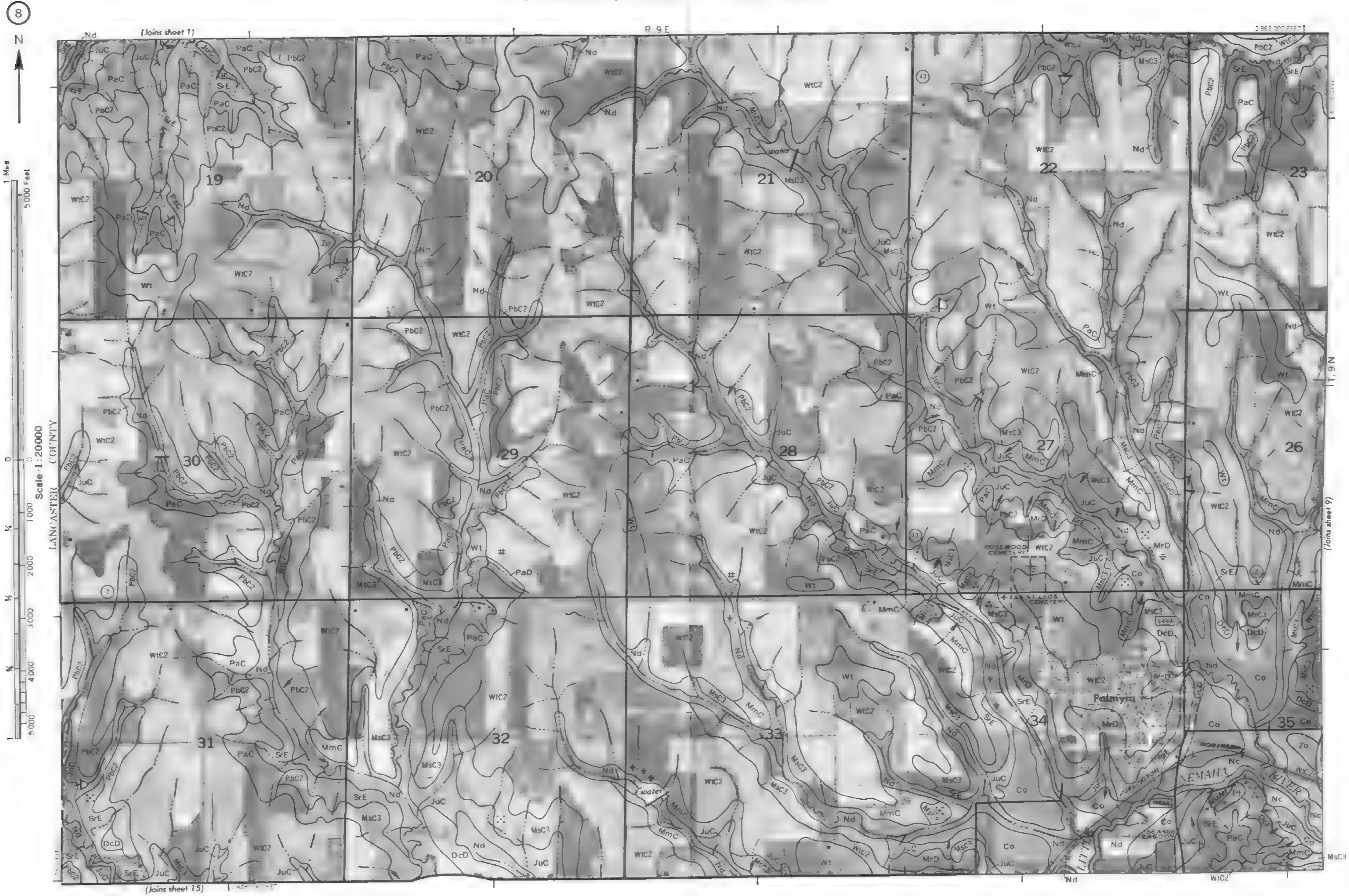
18


8
N
(Joins sheet 1)
R. 9 E.
T. 9 N.
(Joins sheet 9)
(Joins sheet 15)
LANCASTER COUNTY
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
23
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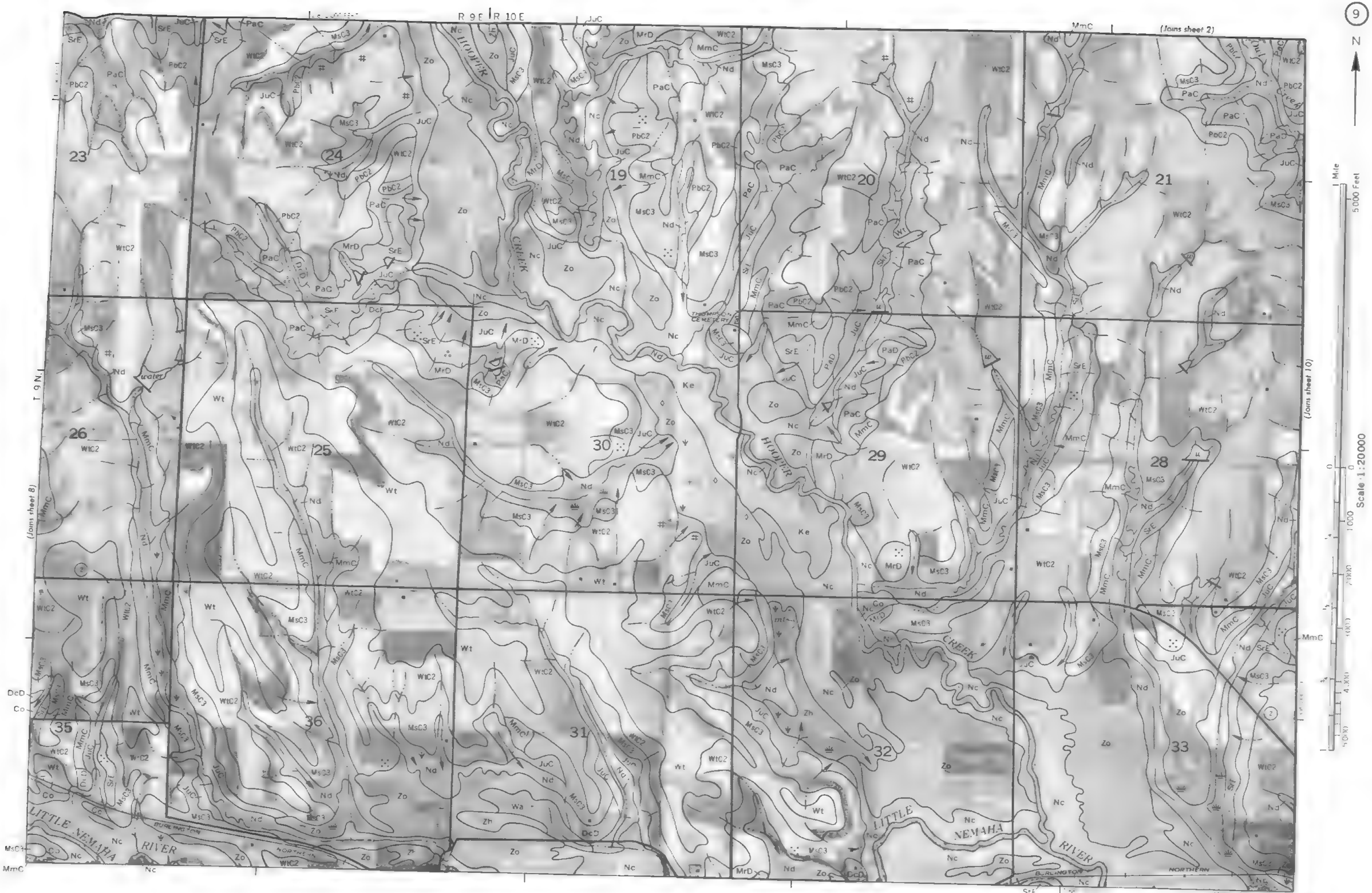
29
30
31
32
33
34
35
ROSEWOOD CEMETERY
Palmyra
NEMAHA RIVER
water


9
N
R 9 E
R 10 E
T 9 N
(Joins sheet 2)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 16)
(Joins 17)
HOOPER CREEK
LITTLE NEMAHA RIVER
THOMPSON CEMETERY
BURLINGTON NORTHERN
water
19
20
21
23
24
25
26
28
29
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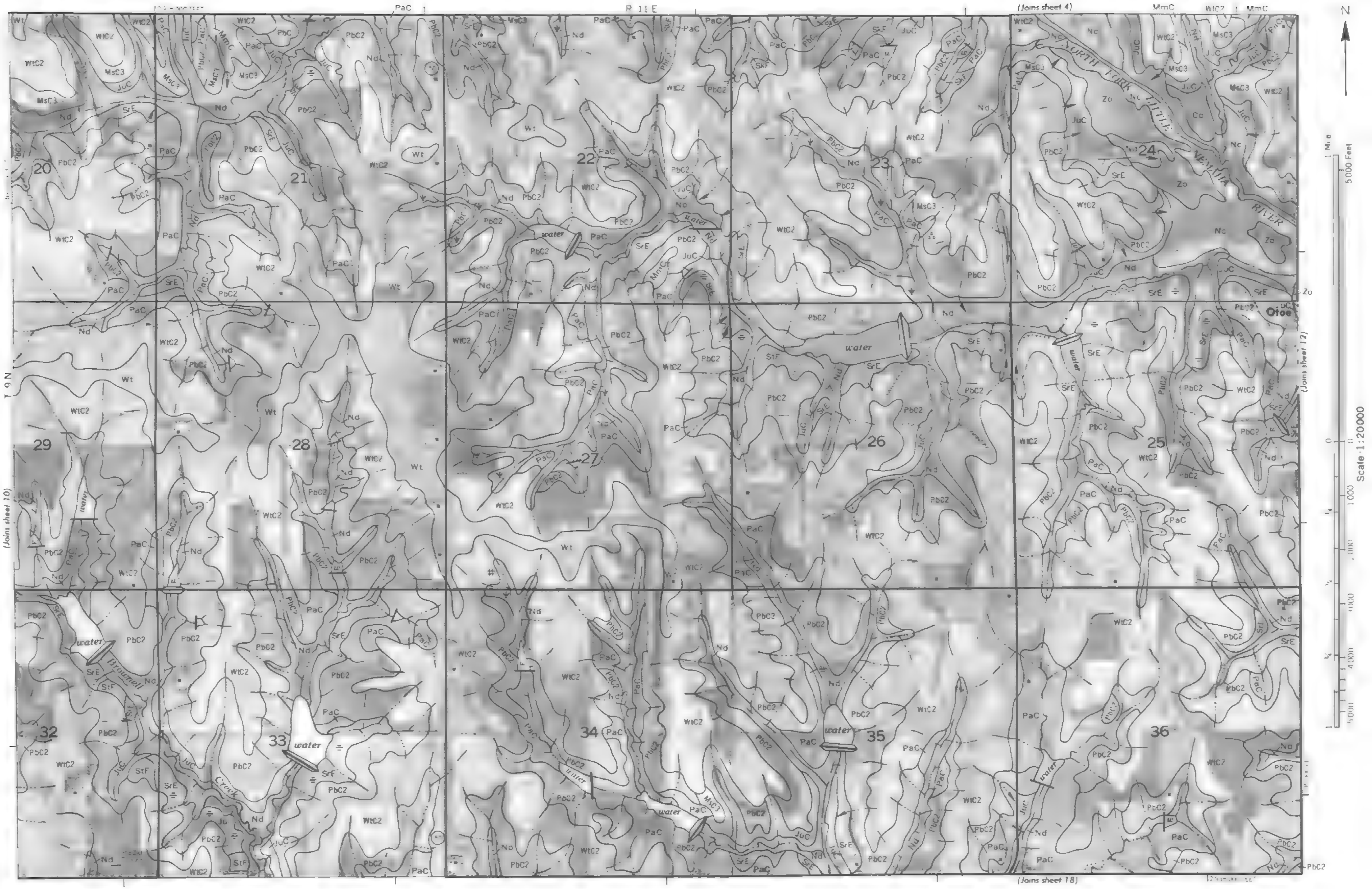
31
32
33
35
36
1 Mile
5000 Feet
Scale 1:20000

OTOE COUNTY, NEBRASKA NO. 10


R 11 E
T 9 N
(Joins sheet 4)
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 18)
N
1 Mile
5000 Feet
Scale 1:20000
Otoe
NORTH FORK LITTLE NEMAHA RIVER
Brownell
Creek
20
21
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23
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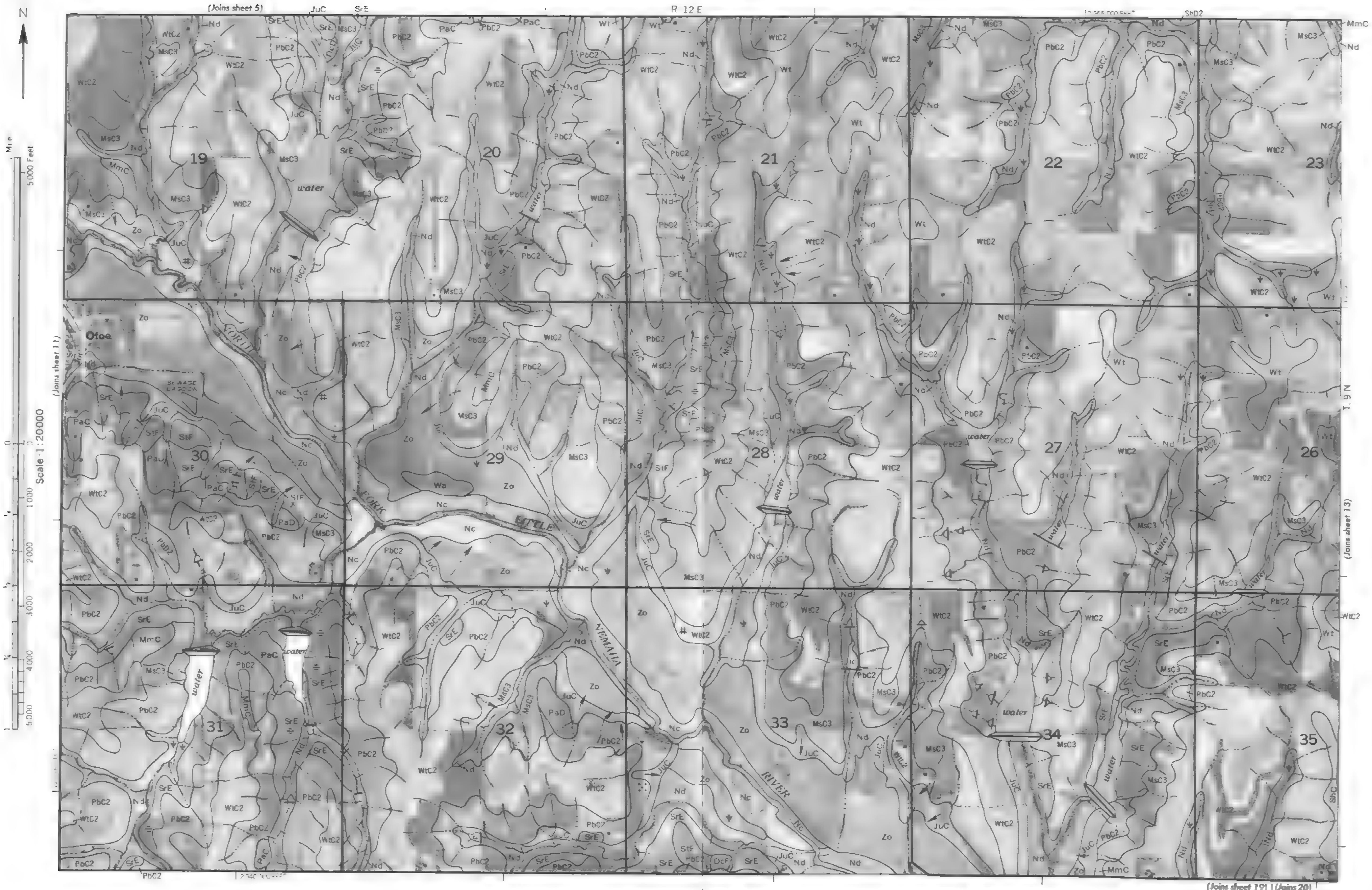
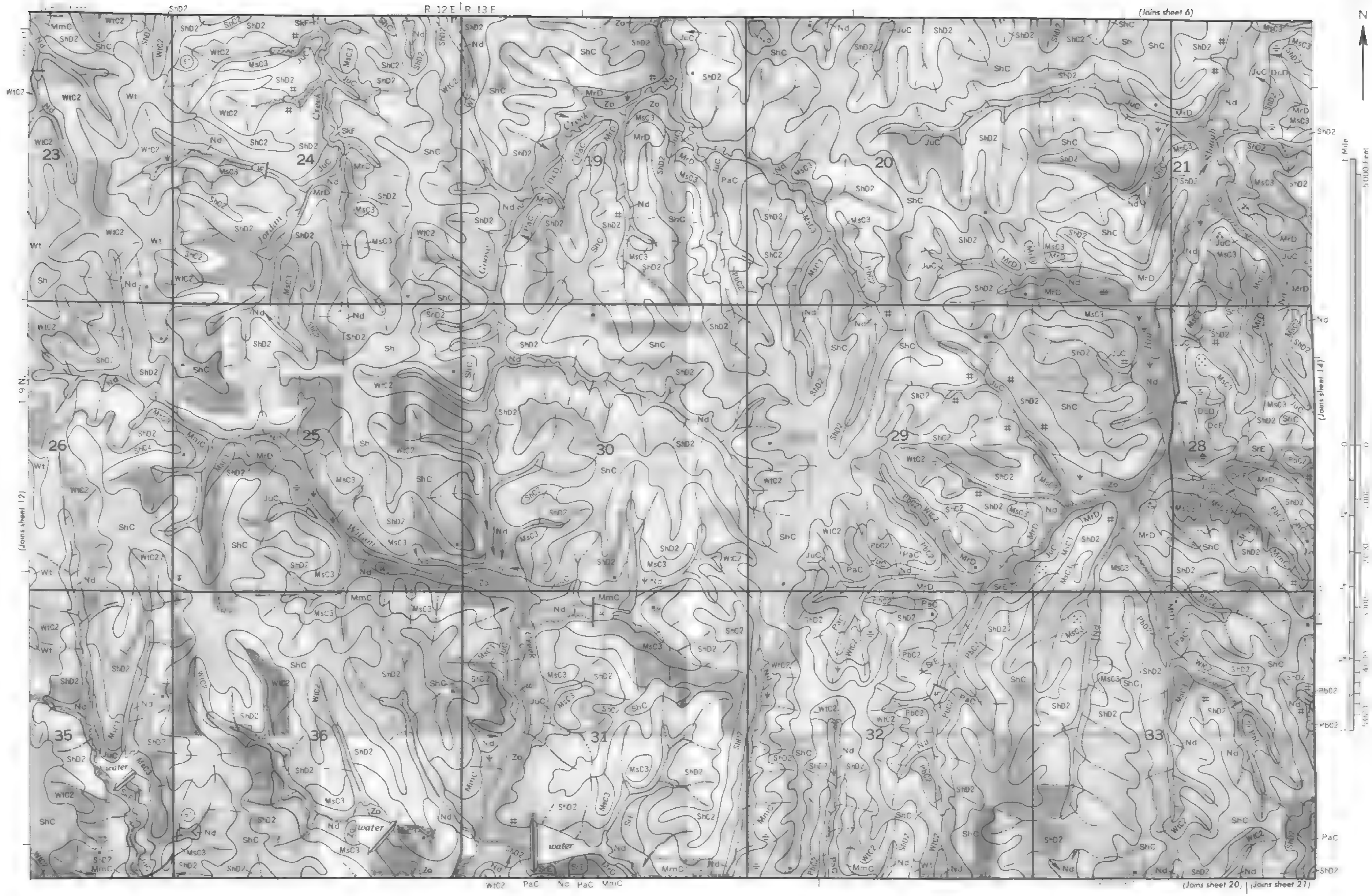
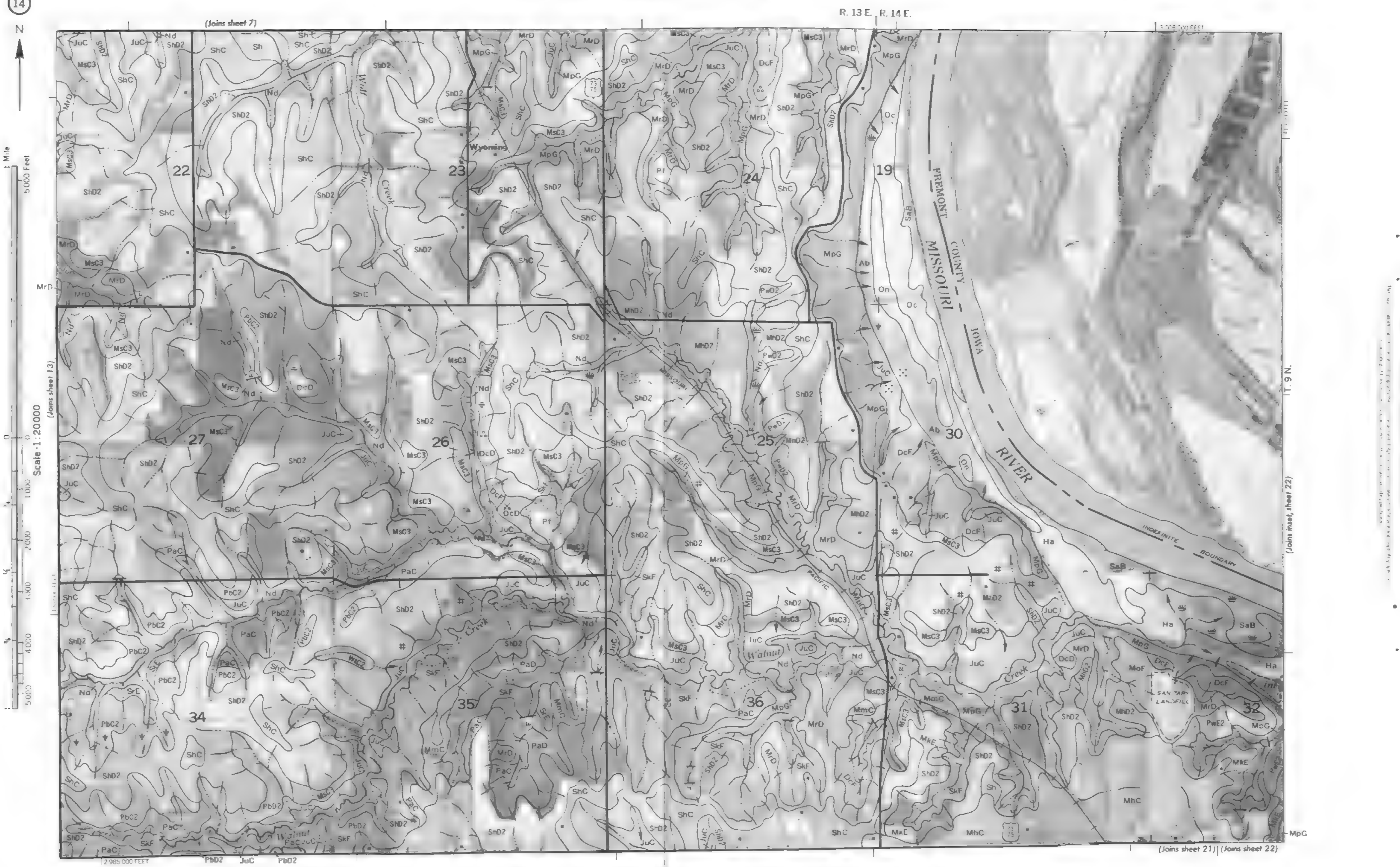
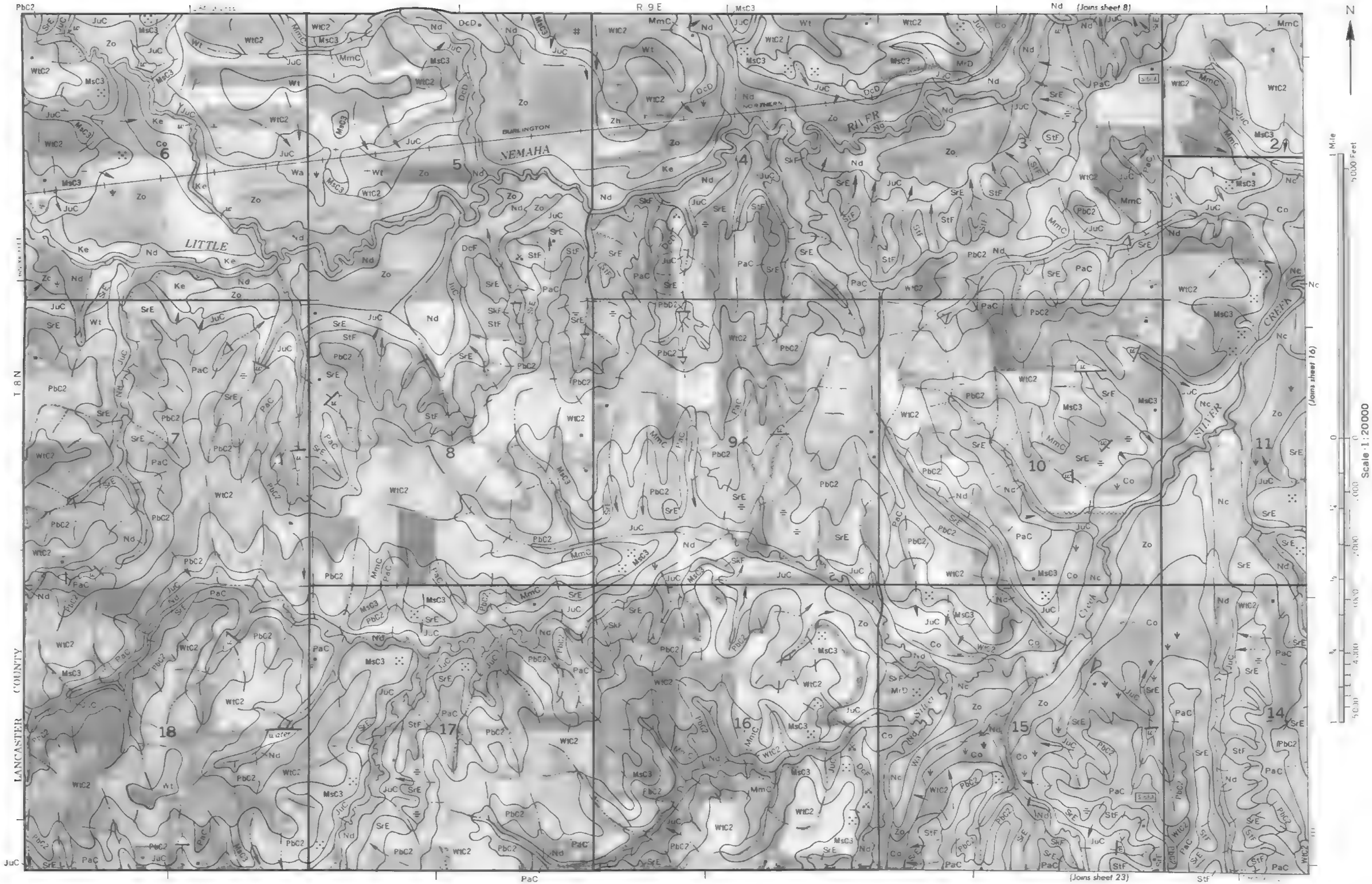
36

OTOE COUNTY, NEBRASKA — SHEET NUMBER 12




13
N
(Joins sheet 6)
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 20)
(Joins sheet 21)
R 12 E
R 13 E
T 9 N
1 Mile
5000 Feet
Scale 1:20000
water


(Joins sheet 7)
R. 13 E. R. 14 E.
N
Scale 1:20000
1 Mile
5000 Feet
(Joins sheet 13)
(Joins inset, sheet 22)
(Joins sheet 21)
(Joins sheet 22)
T. 9 N.
MISSOURI RIVER
FREMONT COUNTY
IOWA
INDEFINITE BOUNDARY
Wyoming
Wolf Creek
Walnut Creek
SANITARY LANDFILL
MISSOURI PACIFIC
22
23
24
19
27
26
25
30
34
35
36
31
32


R 9 E
T 8 N
Nd (Joins sheet 8)
(Joins sheet 16)
(Joins sheet 23)
LANCASTER COUNTY
LITTLE
NEMAHA
RIVER
BURLINGTON
NORTHERN
SILVER
CREEK
Silver
Creek
N
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
6
7
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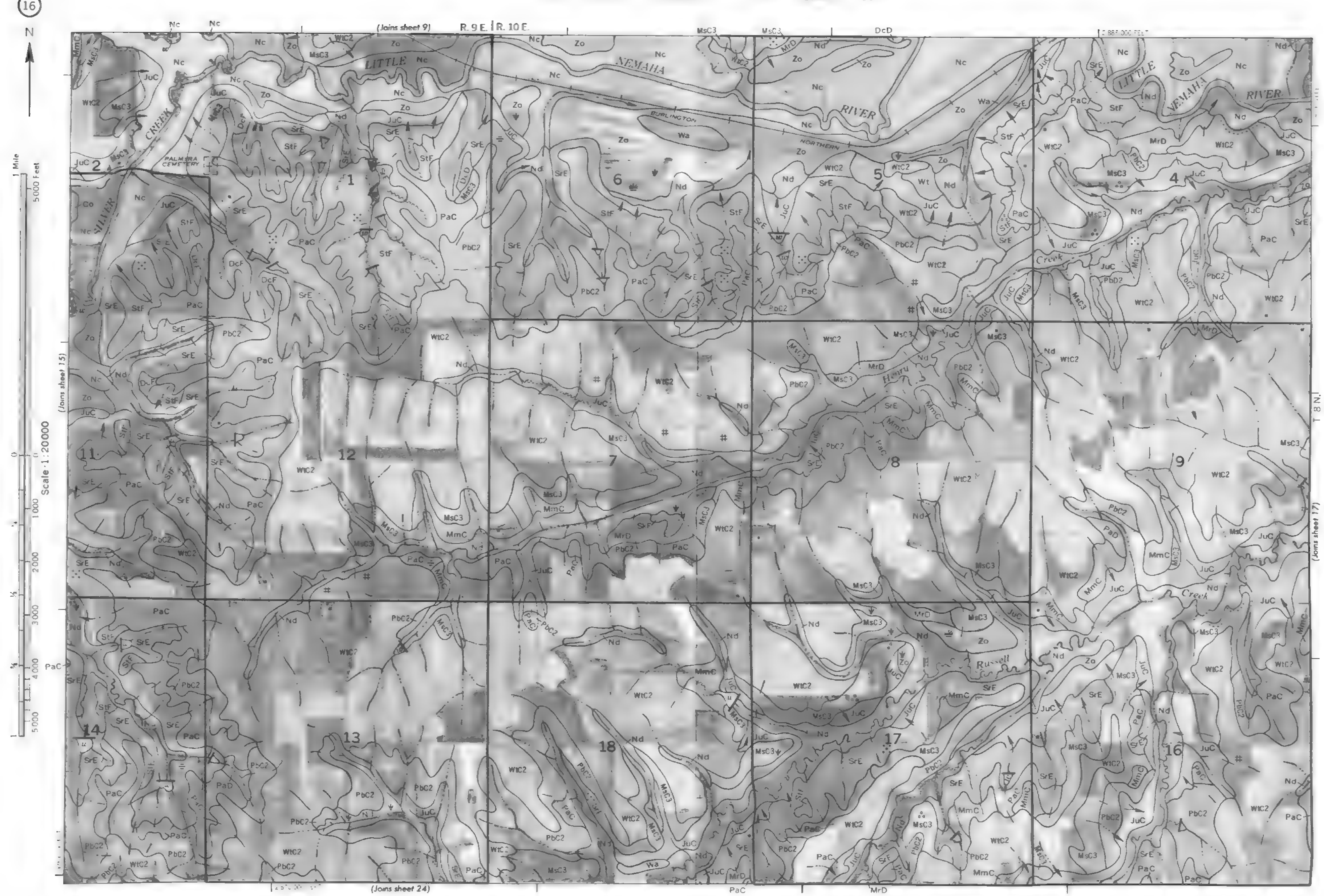
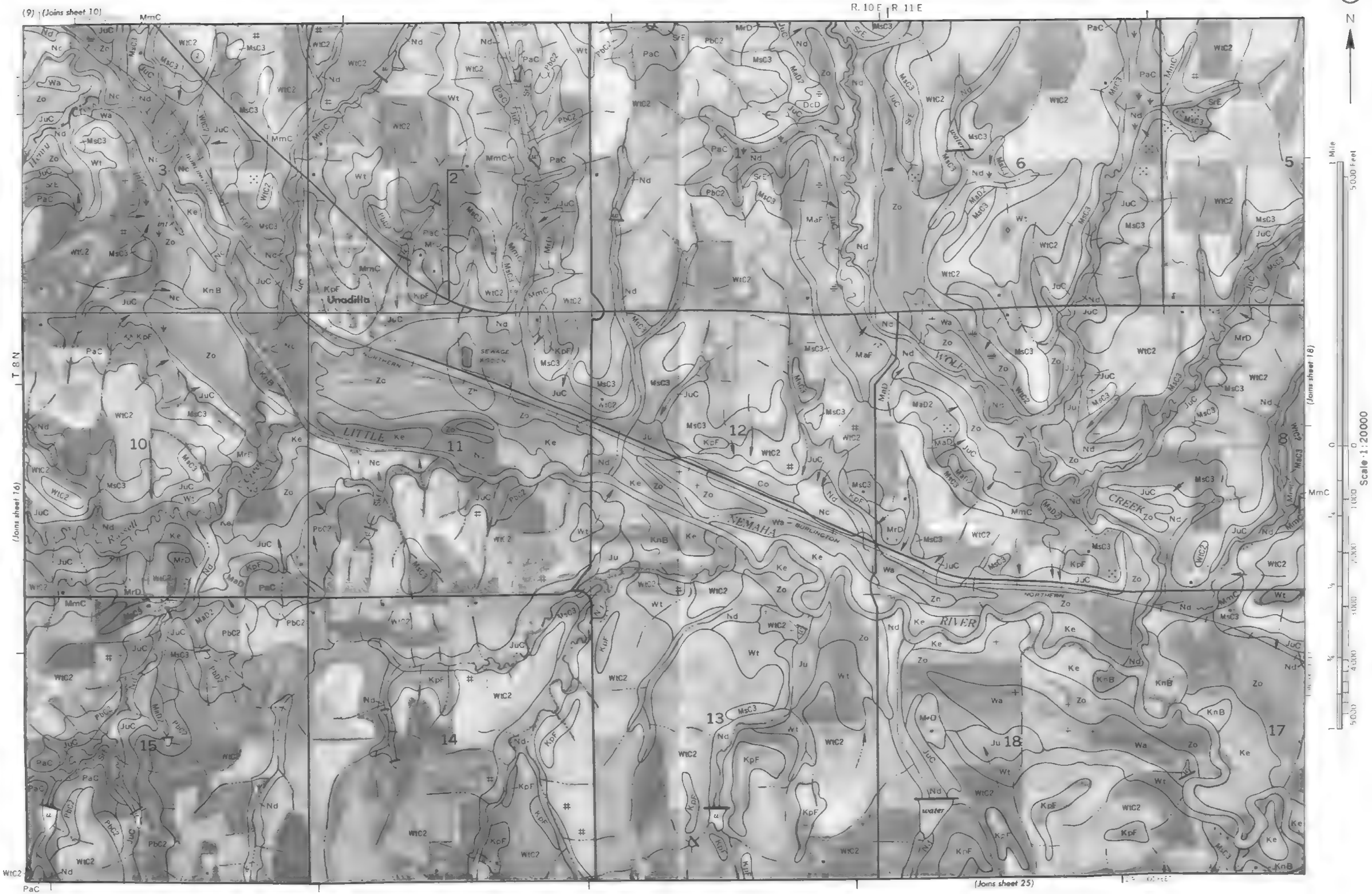
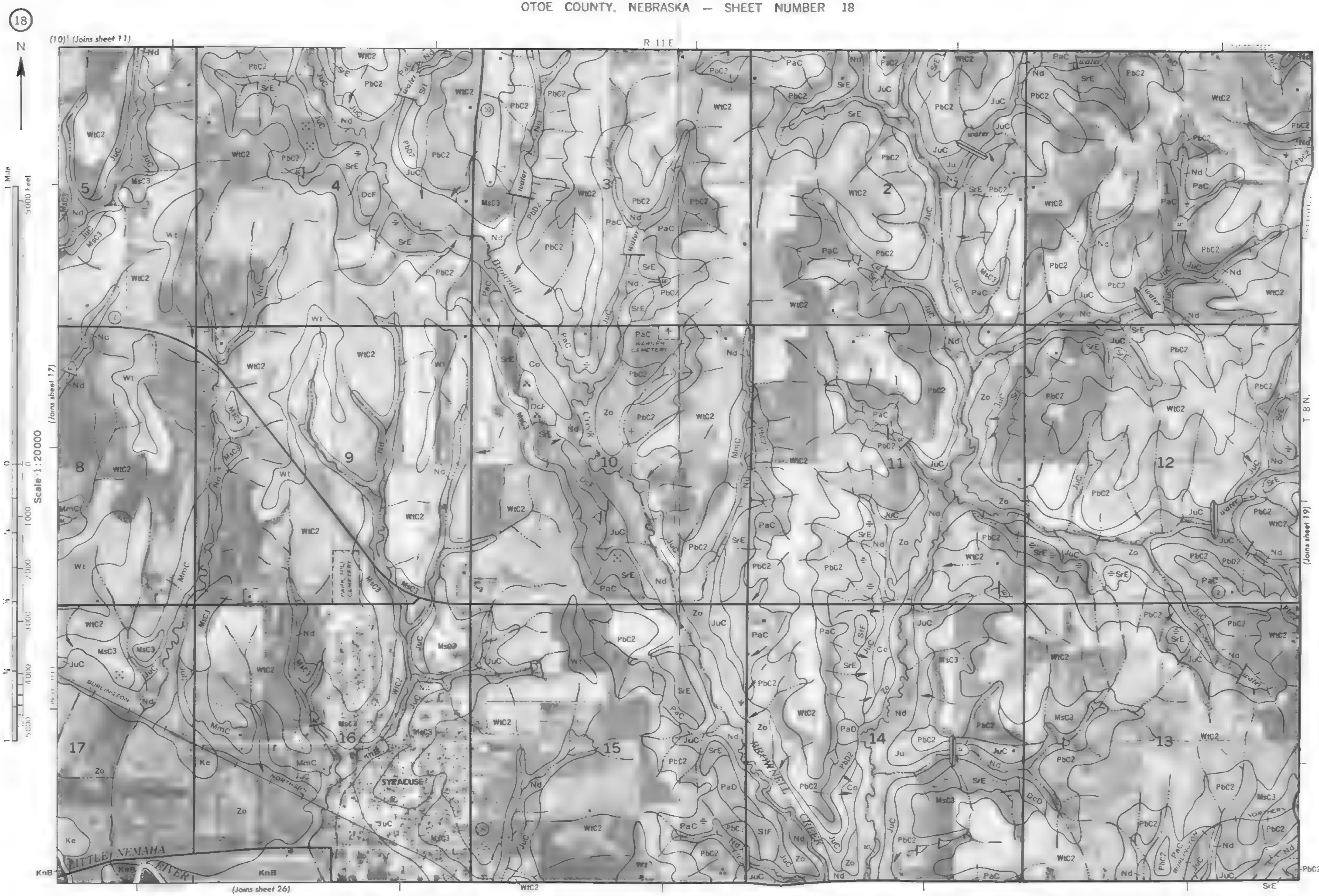
9
10
11
14
15
16
17
18
water

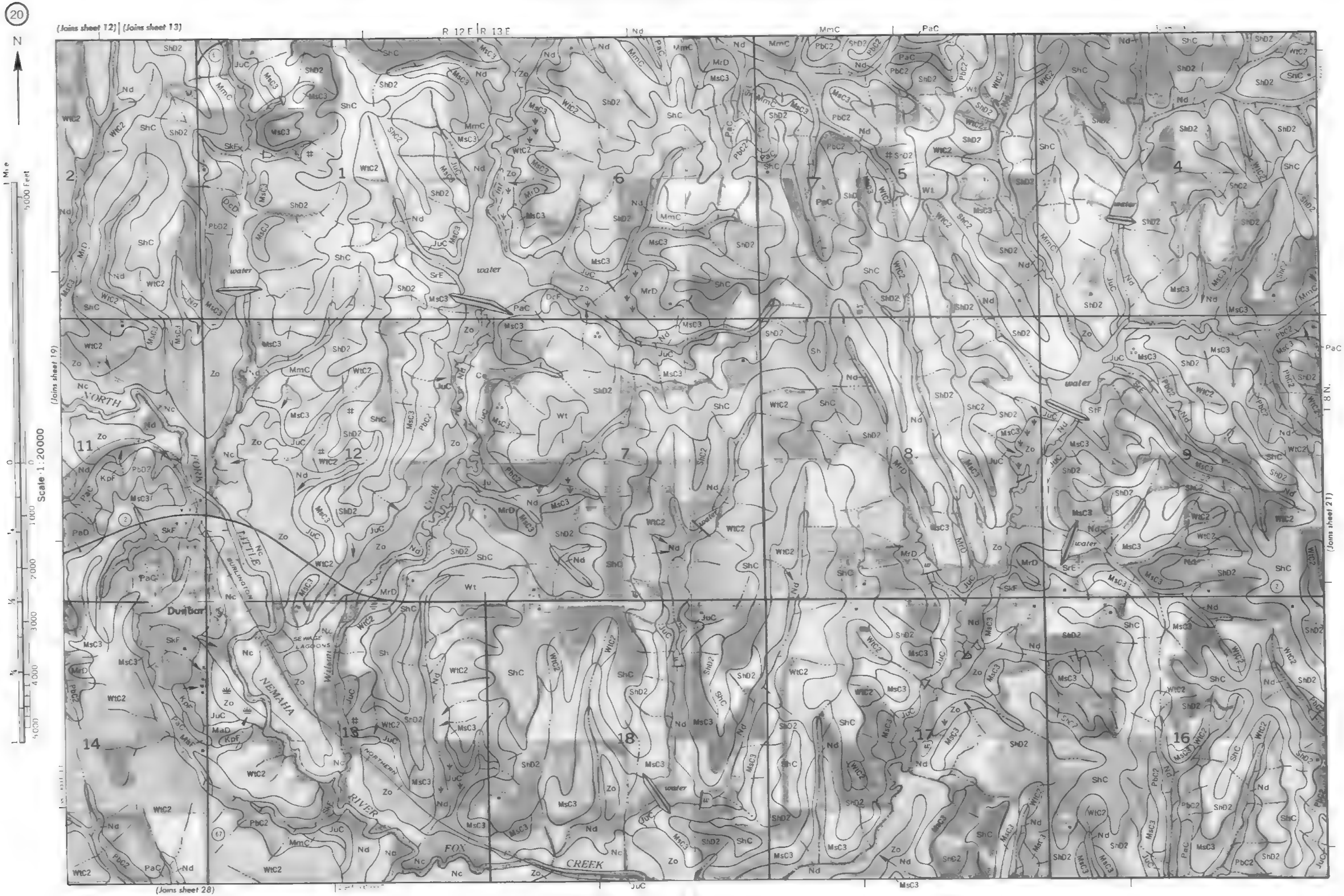
OTOE COUNTY, NEBRASKA — SHEET NUMBER 16

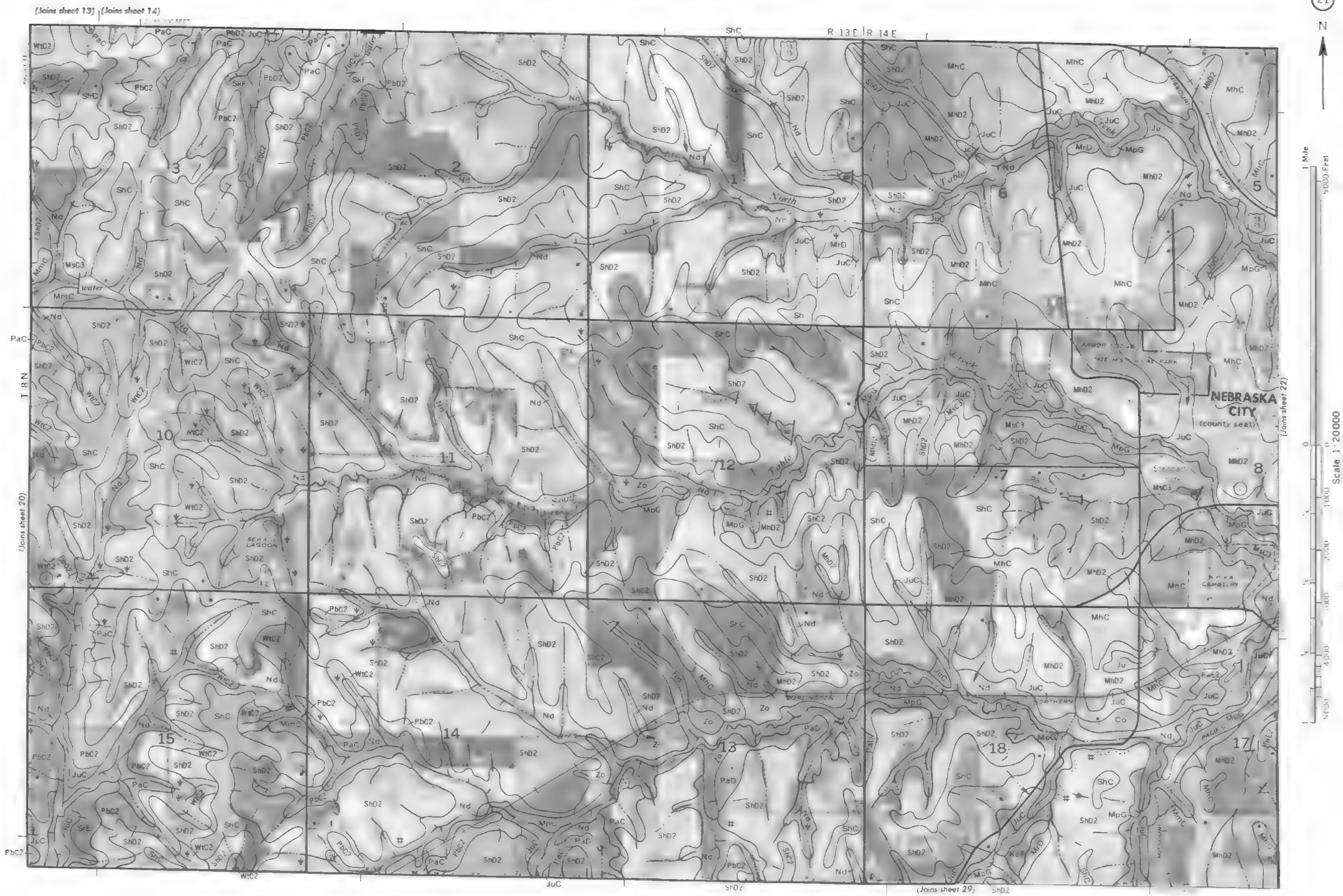


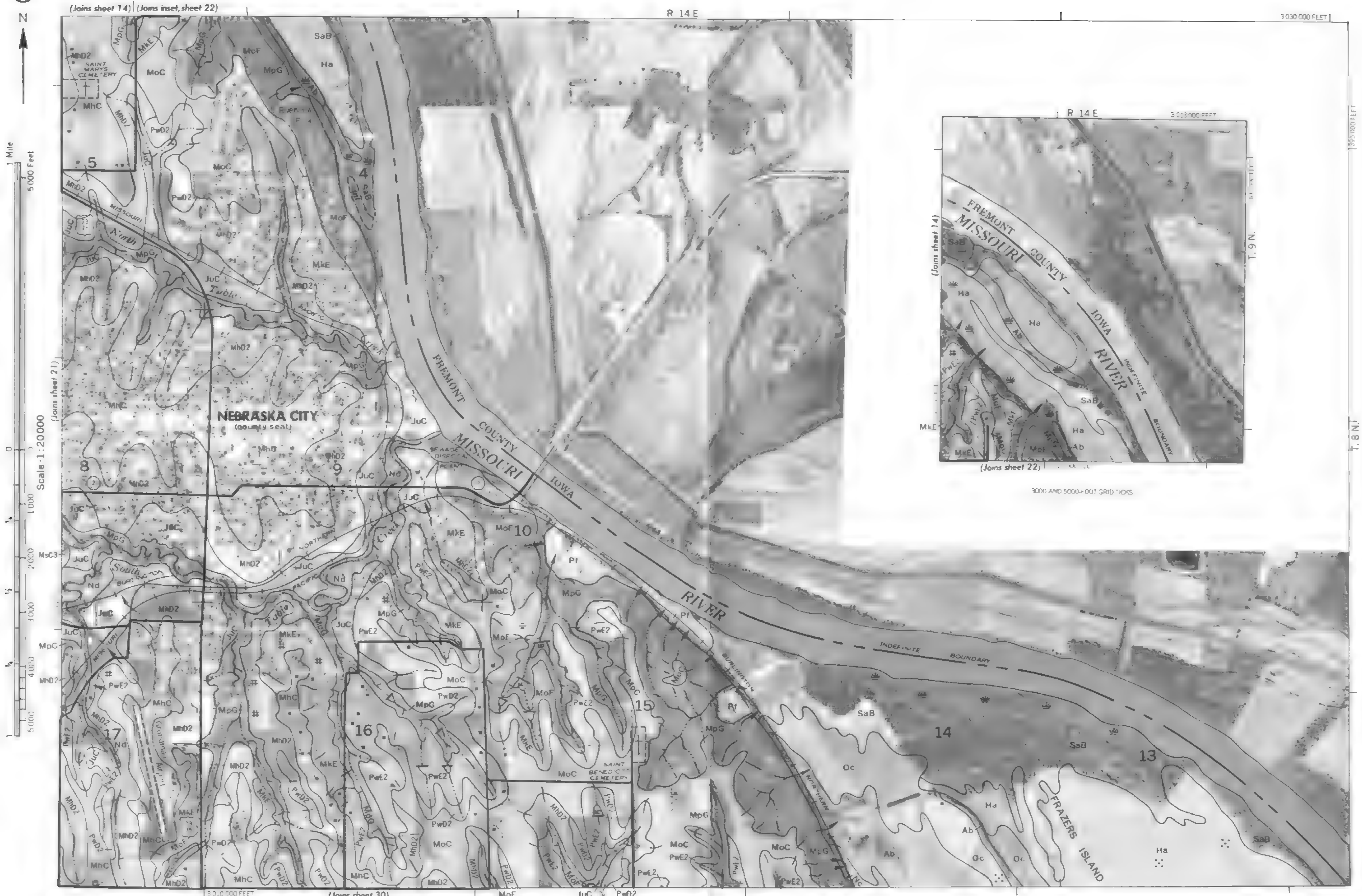

(Joins sheet 10)
R. 10 E. R. 11 E.
17
N
Unadilla
SEWAGE LAGOON
NORTHERN
BURLINGTON
LITTLE
NEMAHA
RIVER
WOLF
CREEK
T. 8 N.
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 25)
Scale 1:20000
1 Mile
5000 Feet

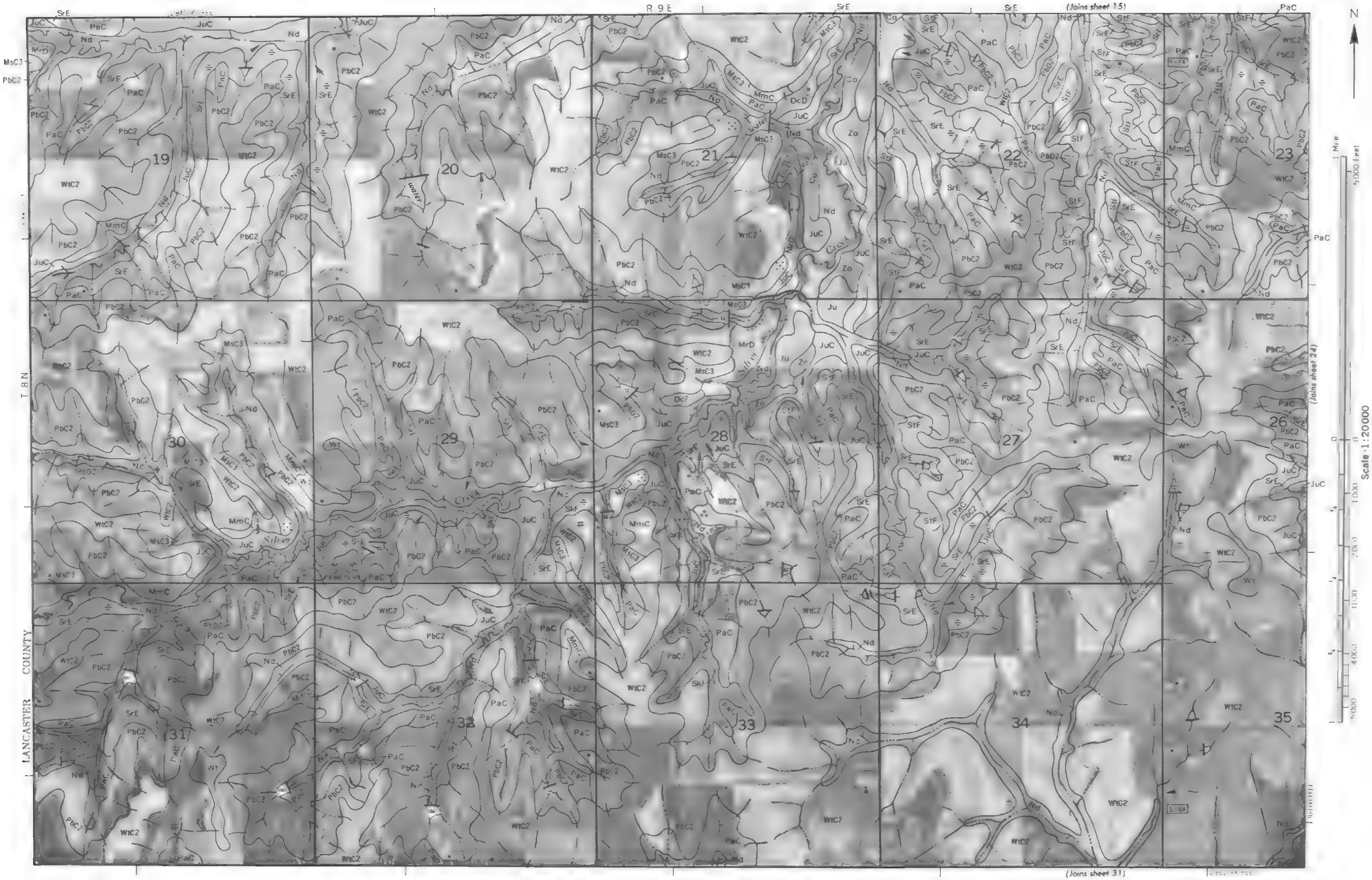

18
N
(Joins sheet 11)
R 11 E
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 26)
T 8 N.
Scale 1:20000
1 Mile
5000 Feet
WARNER CEMETERY
PARK HILL CEMETERY
SYRACUSE
BURLINGTON
NORTHERN
LITTLE NEMAHA RIVER
BROWNELL CREEK
Brownell
Creek
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


19
N
R 12 E
T 8 N
(Joins sheet 12)
(Joins sheet 20)
(Joins sheet 27)
(Joins sheet 18)
NORTH
LITTLE
NEMAHA
RIVER
Deer
Creek
BURLINGTON
NORTHERN
DUNBAR
CEMETERY
Scale 1:20000
1 Mile
5000 Feet


20
N
(Joins sheet 12)
(Joins sheet 13)
R 12 E
R 13 E
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 28)
8 N.
Scale 1:20000
1 Mile
5000 Feet
NORTH
FORK
LITTLE
NEMAHA
RIVER
FOX
CREEK
Creek
Dunbar
SEWAGE LAGOONS
BURLINGTON
NORTHERN
water


21
N
(Joins sheet 13)
(Joins sheet 14)
R 13 E
R 14 E
T 8 N
(Joins sheet 20)
(Joins sheet 22)
(Joins sheet 29)
NEBRASKA CITY
(county seat)
North Table Creek
South Table Creek
Missouri
Pacific
Burlington
Northern
1 Mile
5000 Feet
Scale 1:20000


22
N
(Joins sheet 14)
(Joins inset, sheet 22)
R 14 E
NEBRASKA CITY
(county seat)
MISSOURI RIVER
FREMONT COUNTY
IOWA
FRAZERS ISLAND
SAINT MARYS CEMETERY
SAINT BENEDICTS CEMETERY
(Joins sheet 21)
(Joins sheet 30)
(Joins sheet 22)
Scale 1:20000
5000 Feet
T. 9 N.
T. 8 N.
3000 AND 5000-FOOT GRID TICKS


R 9 E
T 8 N
LANCASTER COUNTY
(Joins sheet 15)
(Joins sheet 24)
(Joins sheet 31)
19
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28
29
30
31
32
33
34
35
N
Scale 1:20000
1 Mile
5000 Feet
Creek
Silver
water


24
N
(Joins sheet 16)
R. 9 E. | R. 10 E.
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 32)
T. 8 N.
Scale 1:20 000
1 Mile
5000 Feet
23
24
19
20
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30
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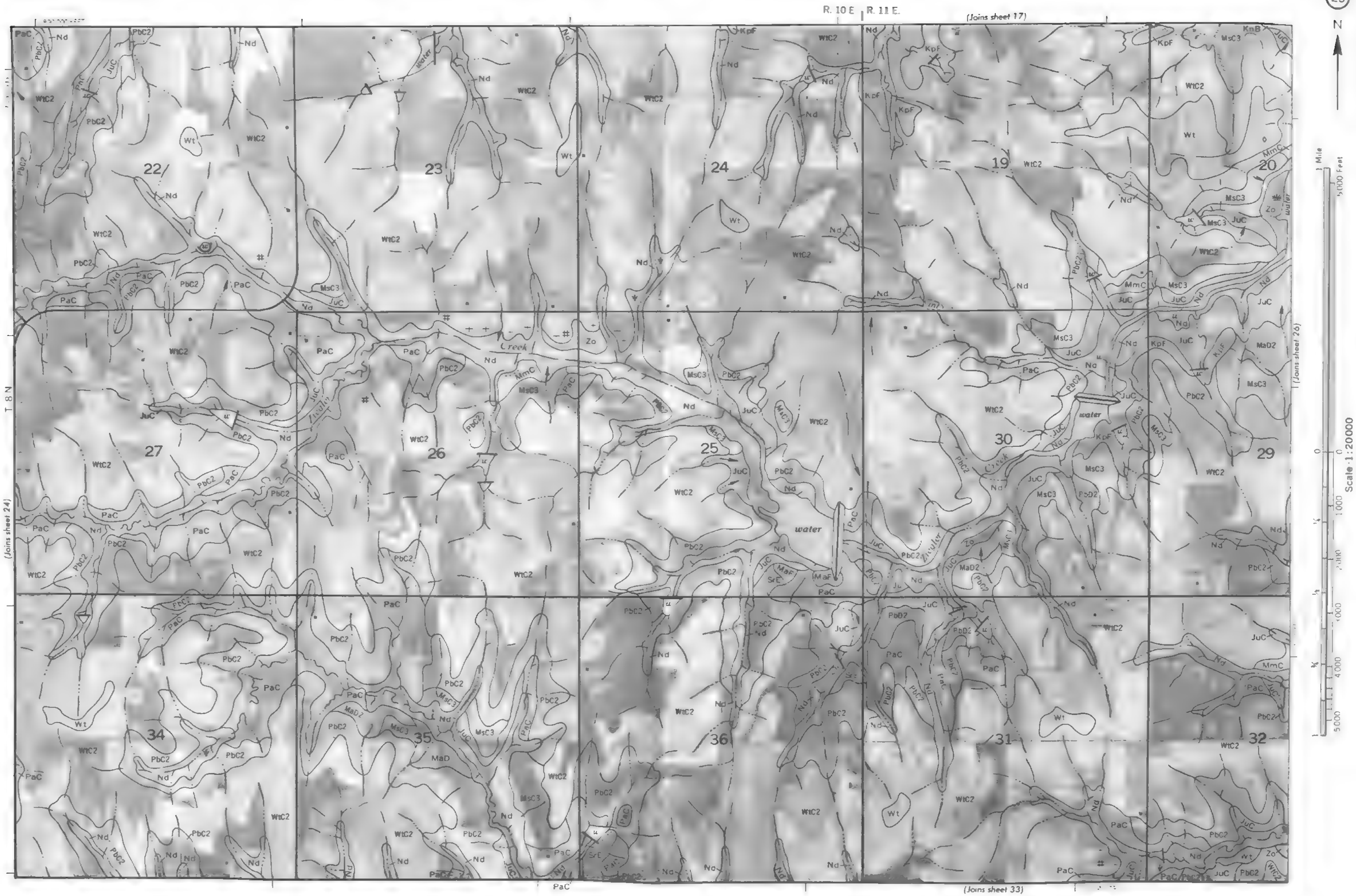
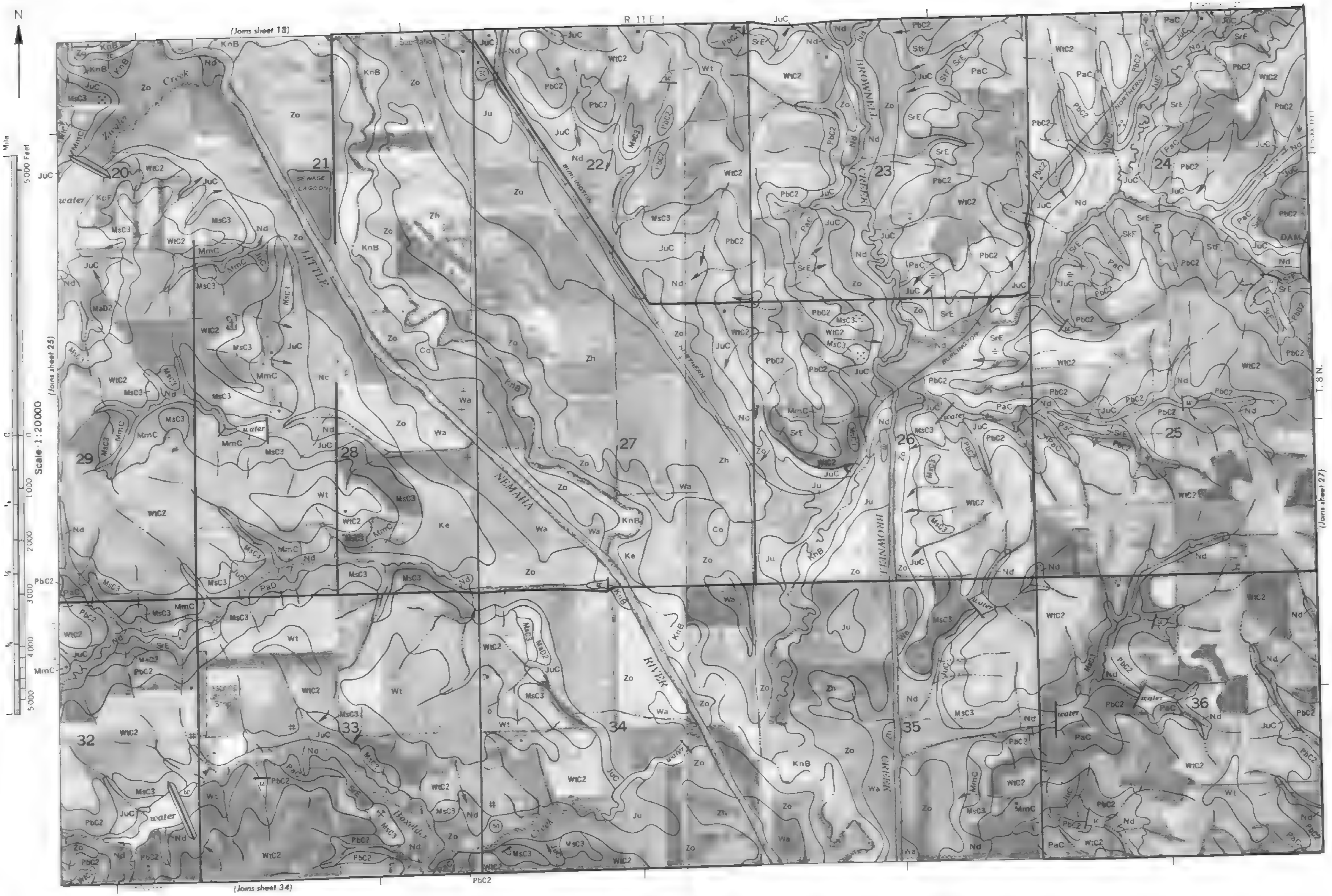
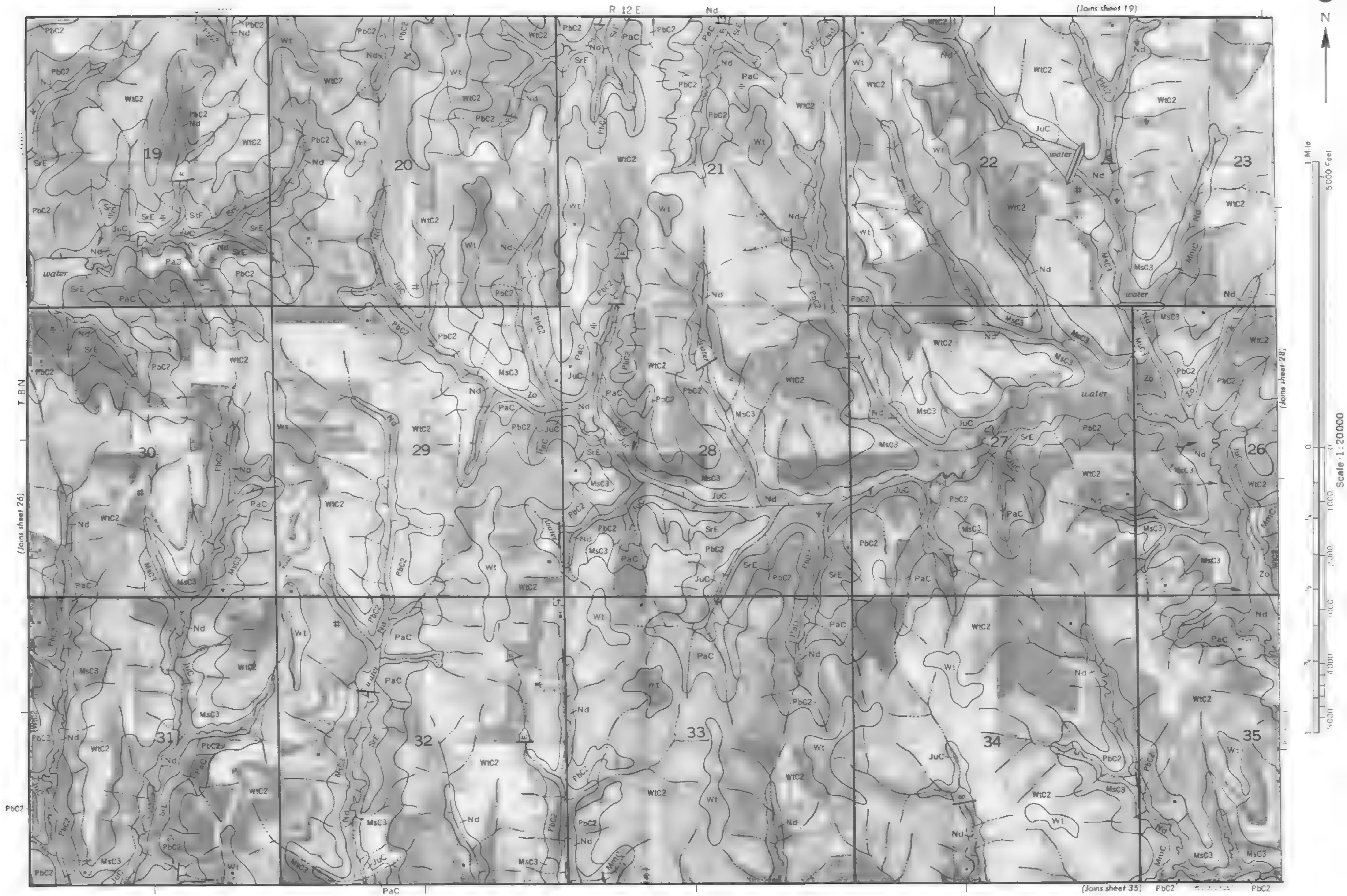
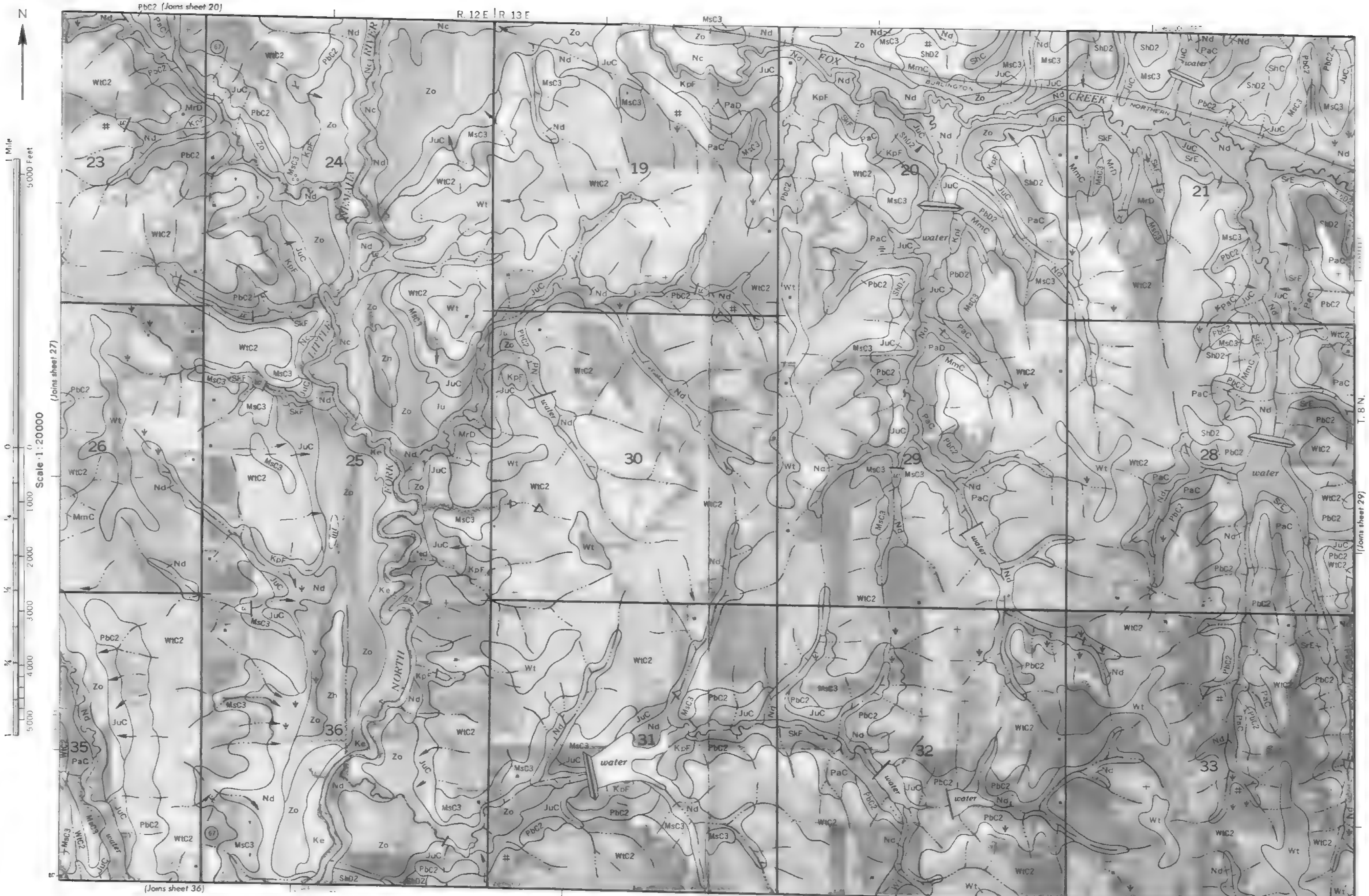
28
35
36
31
32
33
Russell
Muddy
Creek

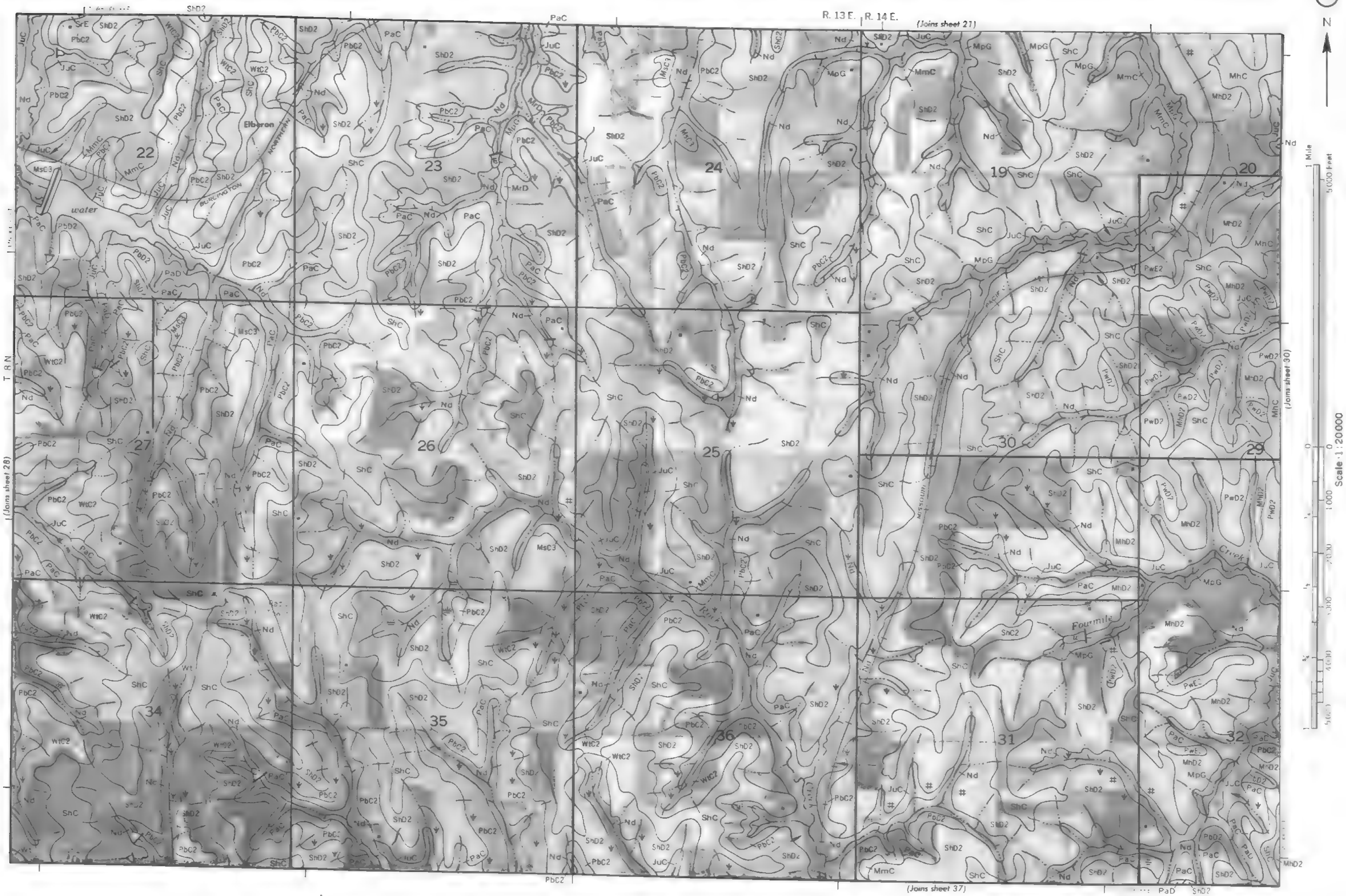

25
N
R. 10 E. | R. 11 E.
(Joins sheet 17)
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 33)
T 8 N
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Creek
Creek
water
water
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000


N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 18)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 34)
R 11 E
T. 8 N.
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
Zeigler Creek
SEWAGE LAGOON
LITTLE NEMAHA RIVER
BURLINGTON NORTHERN
BROWNELL CREEK
Boxelder Creek
DAM
water

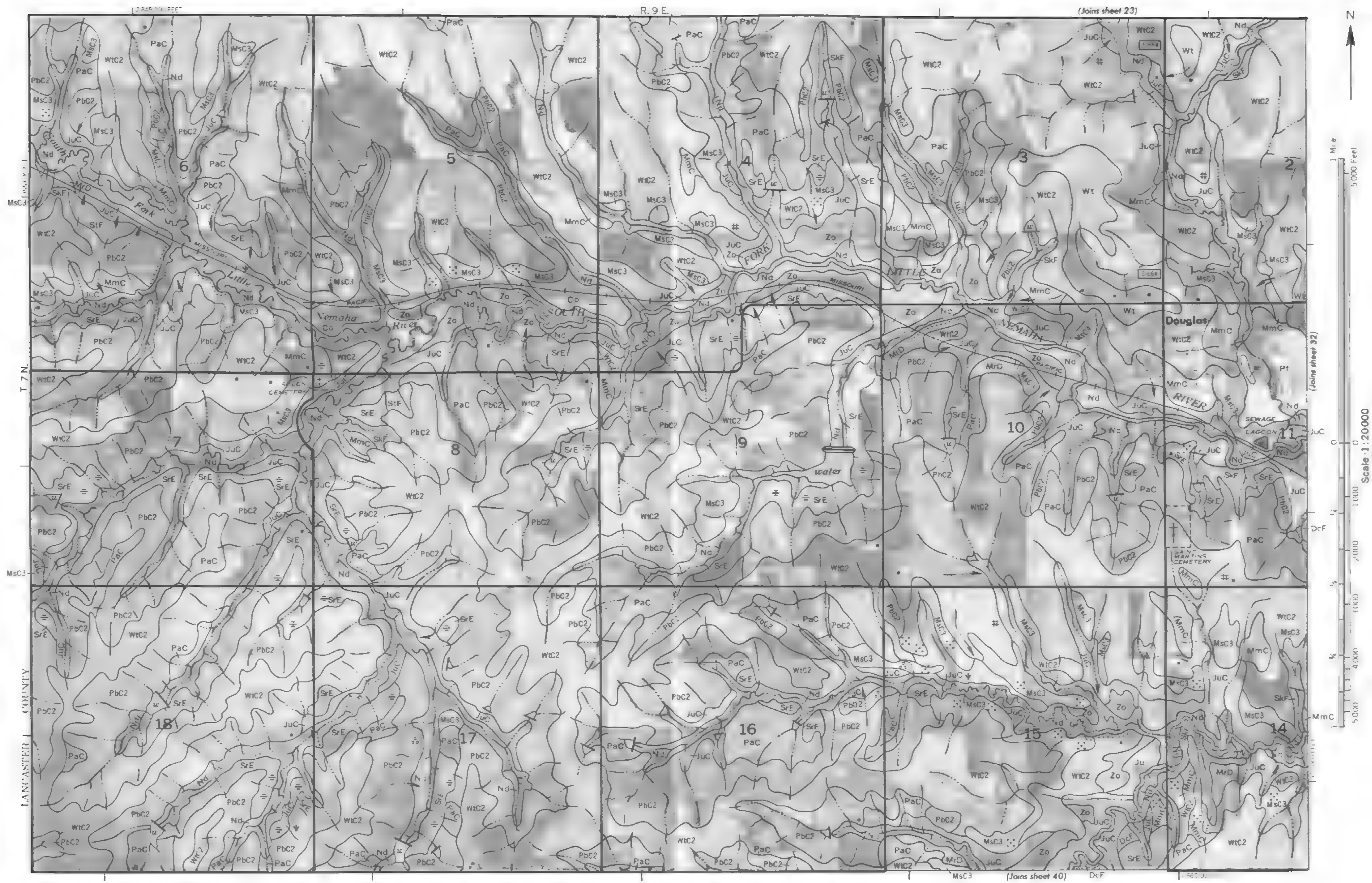

R 12 E.
T 8 N
(Joins sheet 19)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 35)
N
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
water

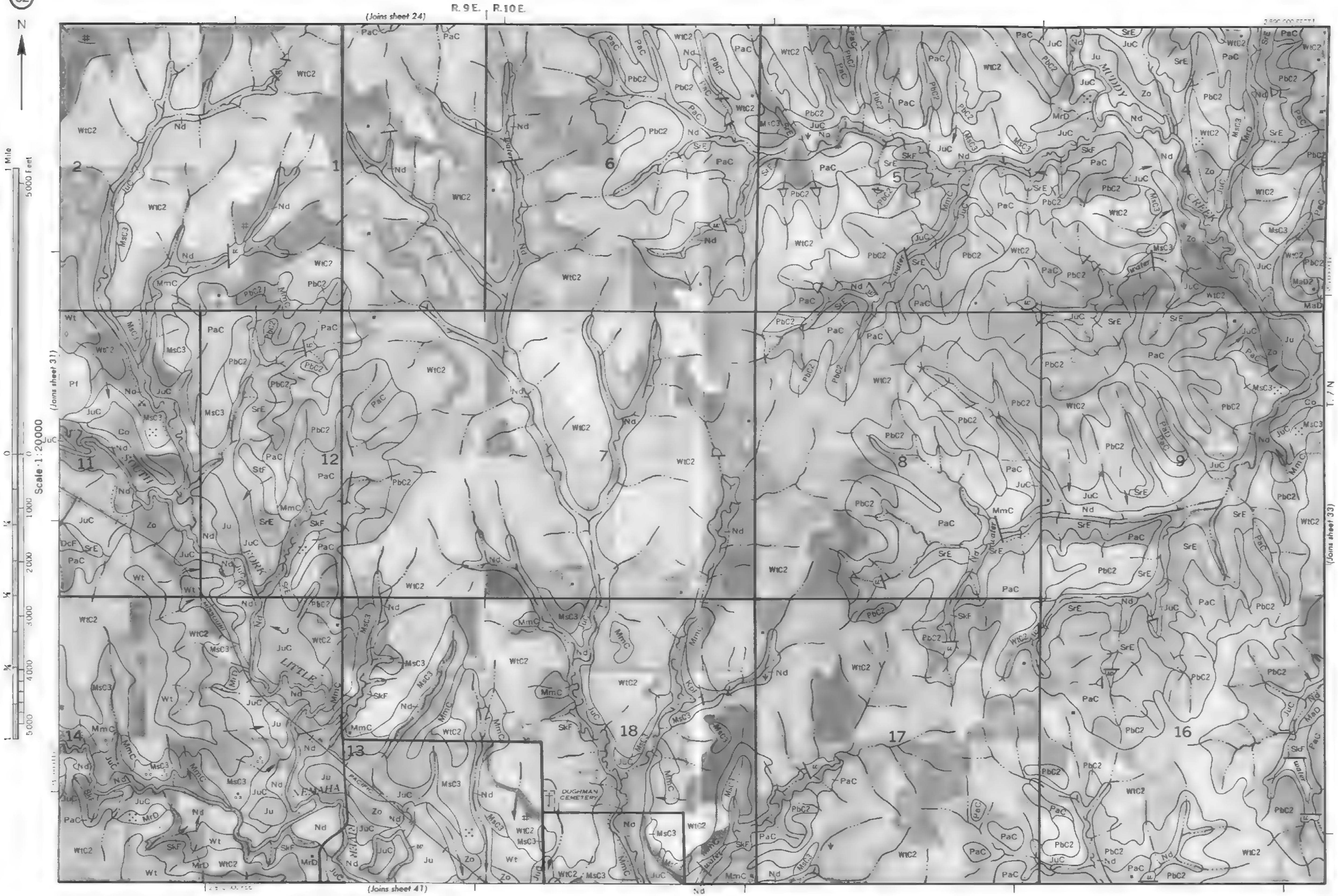
OTOE COUNTY, NEBRASKA — SHEET NUMBER 28

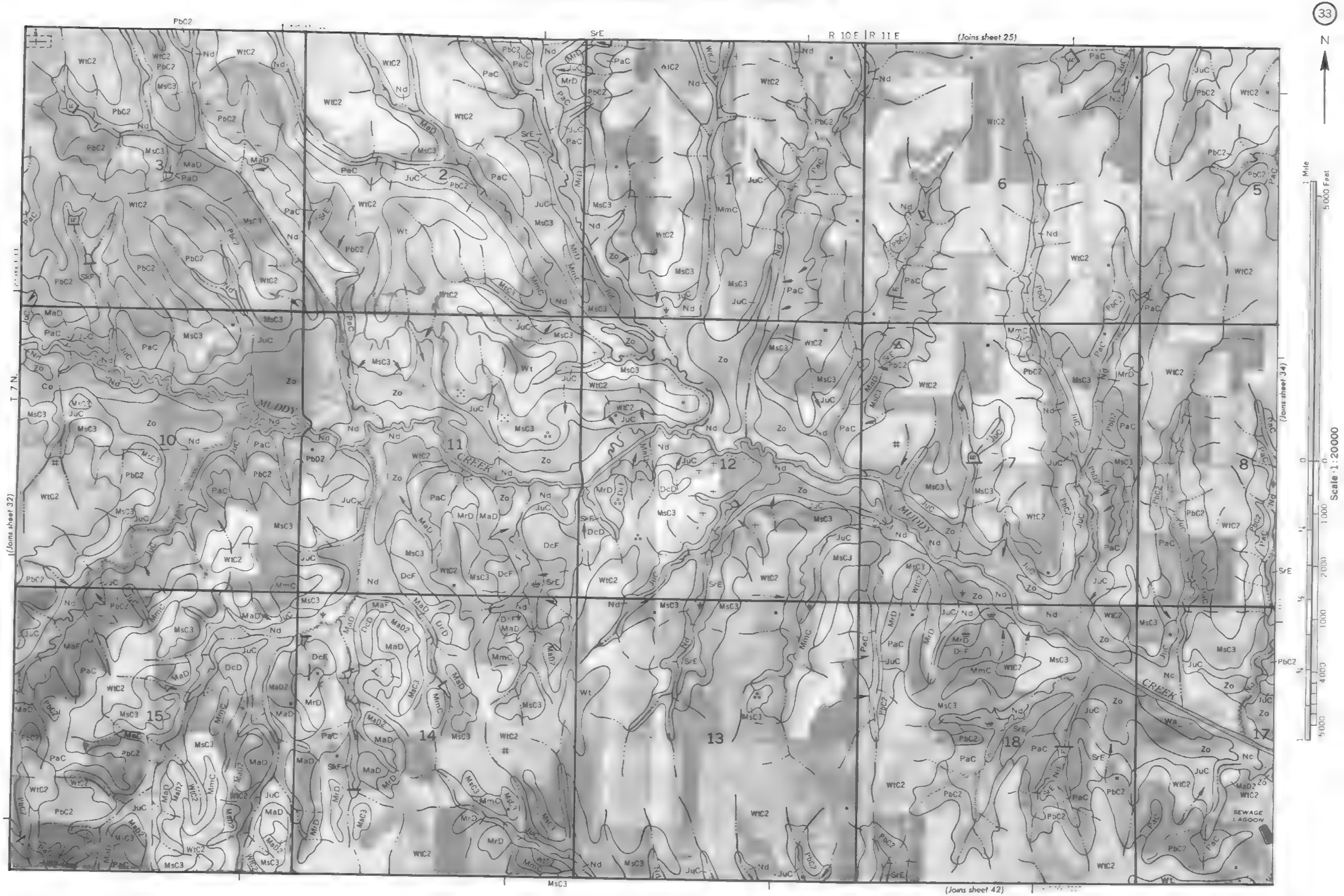


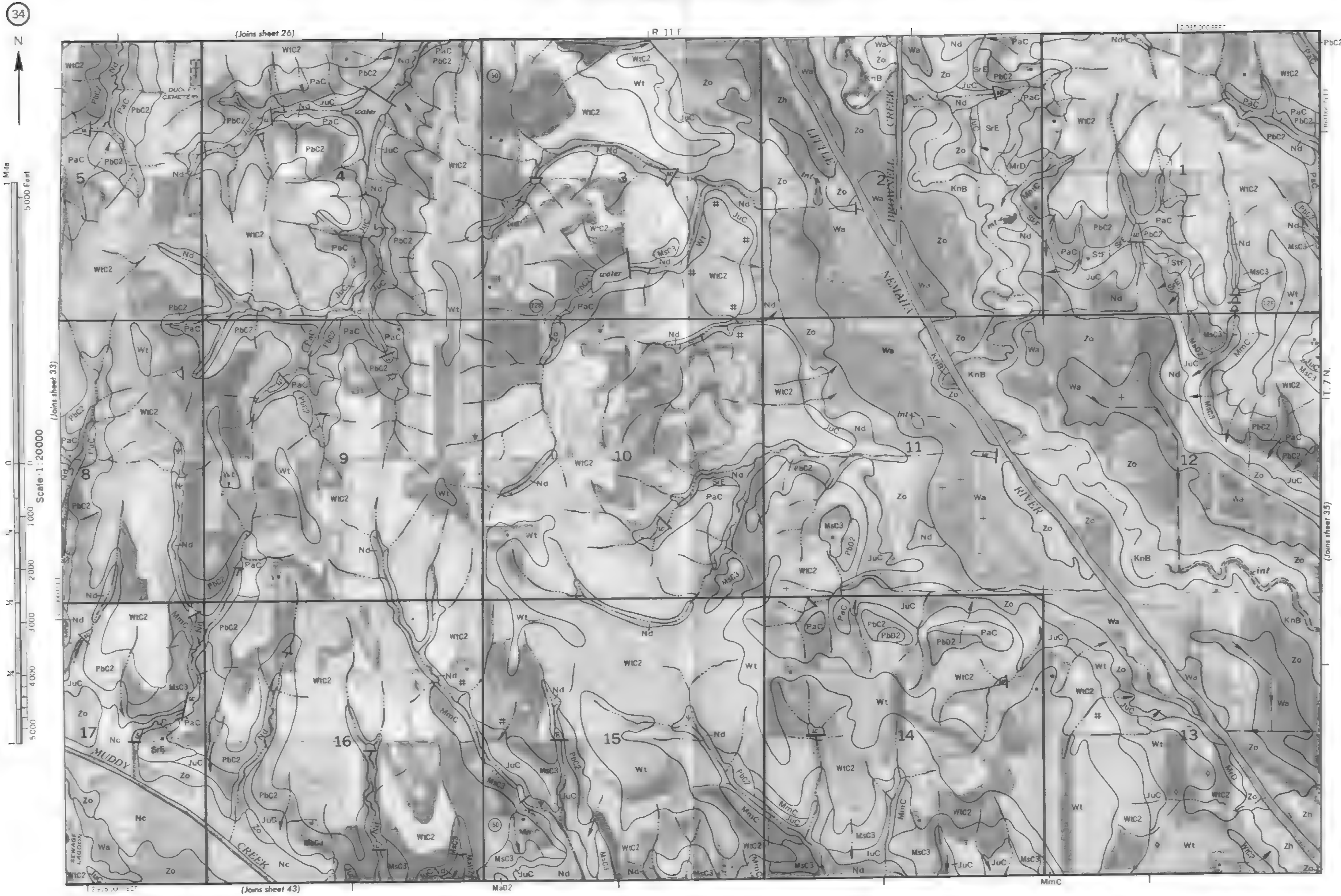

29
N
R. 13 E.
R. 14 E.
(Joins sheet 21)
(Joins sheet 28)
(Joins sheet 30)
(Joins sheet 37)
T 8 N
Elberon
water
Fourmile
Creek
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5000 Feet
Scale 1:20000


30
N
(Joins sheet 22)
R. 14 E.
(Joins sheet 29)
(Joins inset, sheet 39)
(Joins sheet 38)
T. 8 N.
Scale 1:20000
1 Mile
5000 Feet
Threemile Creek
Fourmile Creek
FRAZERS ISLAND
Intermittent
BURLINGTON NORTHERN
CEMETERY
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


R. 9 E.
(Joins sheet 23)
(Joins sheet 32)
(Joins sheet 40)
T. 7 N.
LANCASTER COUNTY
Douglas
SOUTH FORK
LITTLE NEMAHA RIVER
Nemaha River
MISSOURI PACIFIC
water
SEWAGE LAGOON
ST. MARTINS CEMETERY
N
1 Mile
5000 Feet
Scale 1:20000

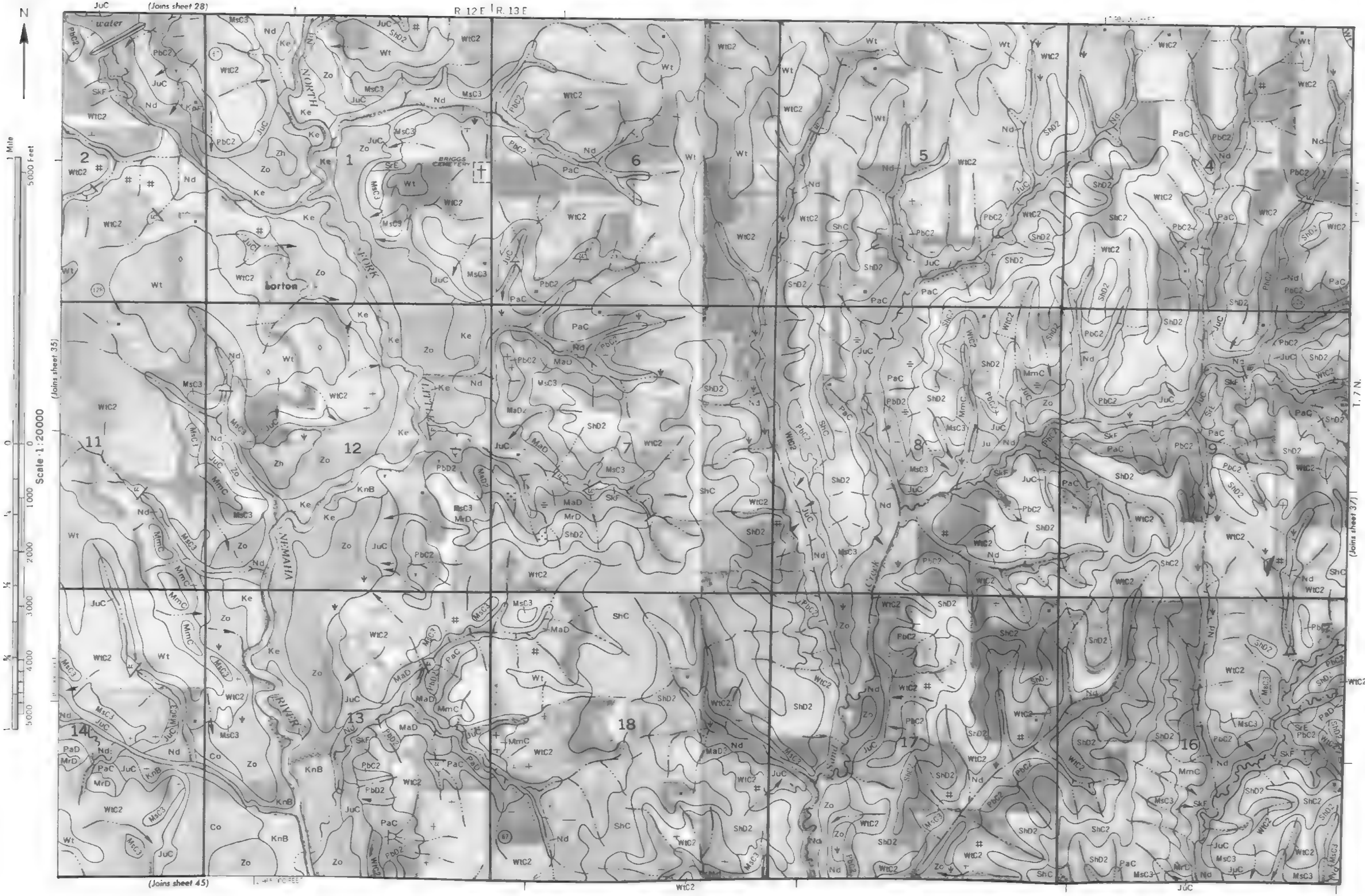

32
N
R. 9 E.
R. 10 E.
(Joins sheet 24)
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 41)
T. 7 N.
Scale 1:20000
1 Mile
5000 Feet
MUDDY CREEK
LITTLE NEMAHA RIVER
NORTH FORK
DUGHMAN CEMETERY
PACIFIC
OTOE COUNTY, NEBRASKA NO. 32

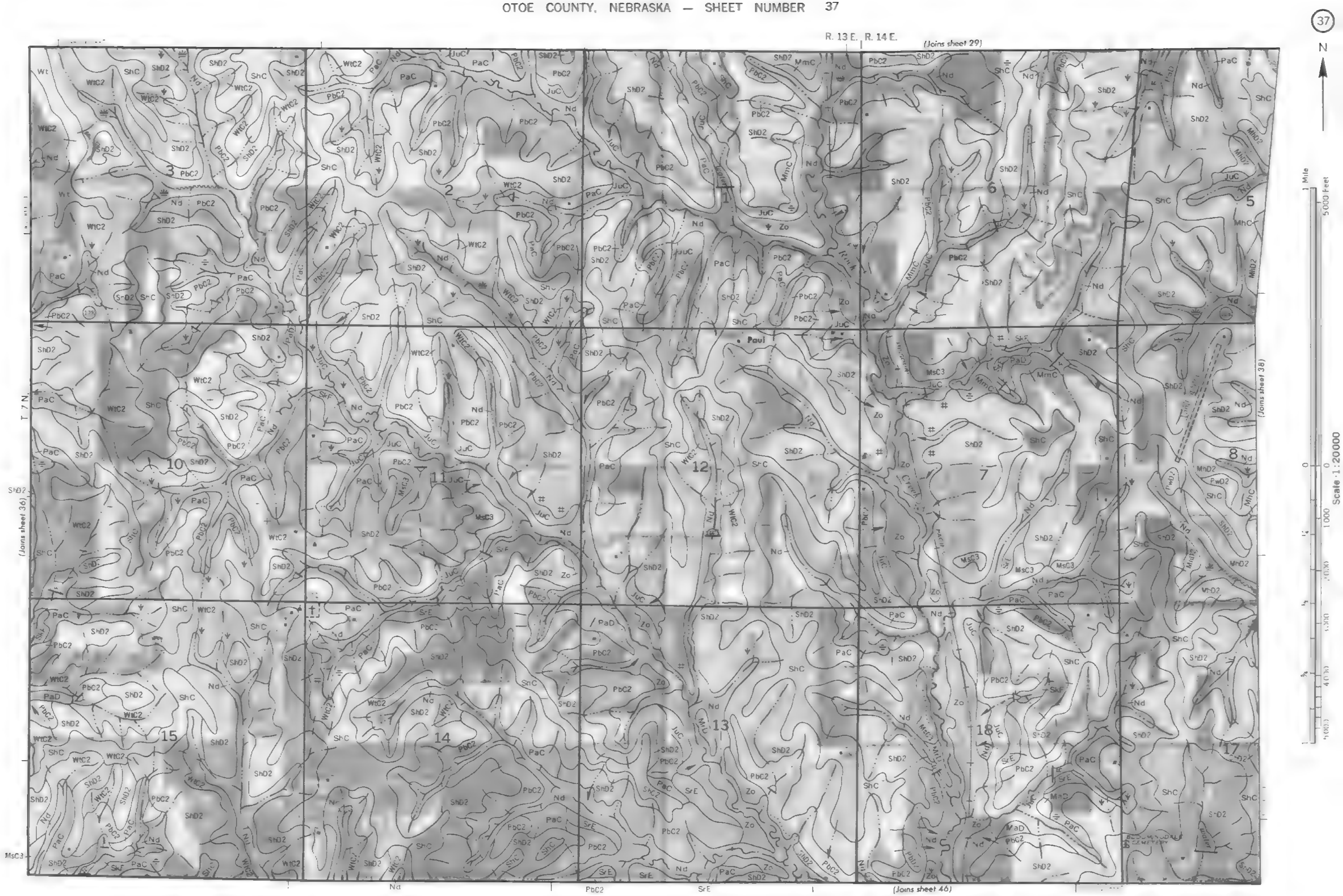

33
N
(Joins sheet 25)
R 10 E | R 11 E
T 7 N.
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 42)
MUDDY
CREEK
MUDDY
CREEK
SEWAGE LAGOON
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

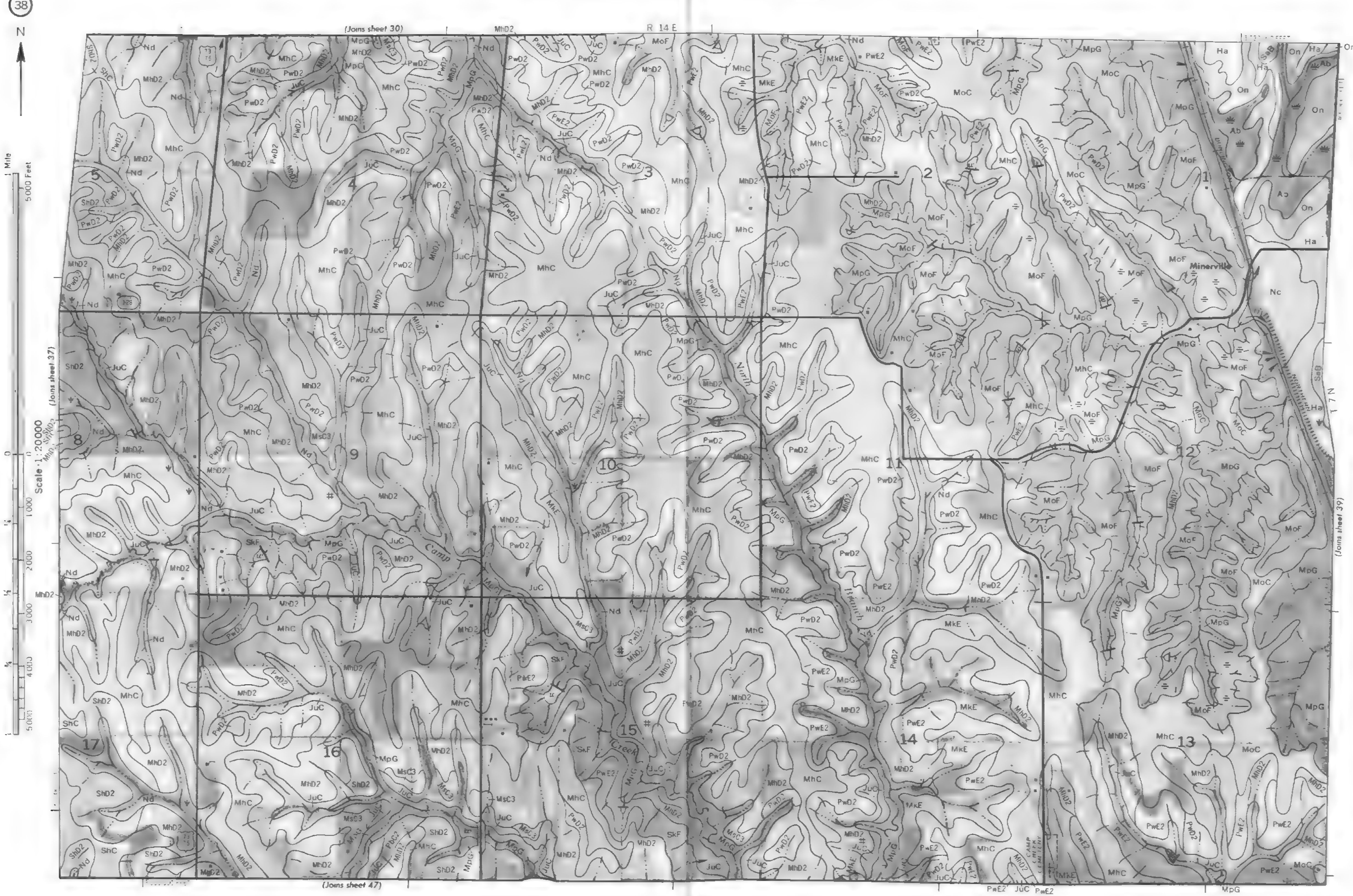

34
N
(Joins sheet 26)
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 43)
R 11 E
T. 7 N.
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
LITTLE NEMAHA RIVER
MUDDY CREEK
SEWAGE LAGOON
water
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
WtC2
PbC2
PaC
JuC
Nd
Zo
Wa
Wt
KnB
MsC3
MmC
SrE
StF
Nc
Zh
MrD
PbD2
int

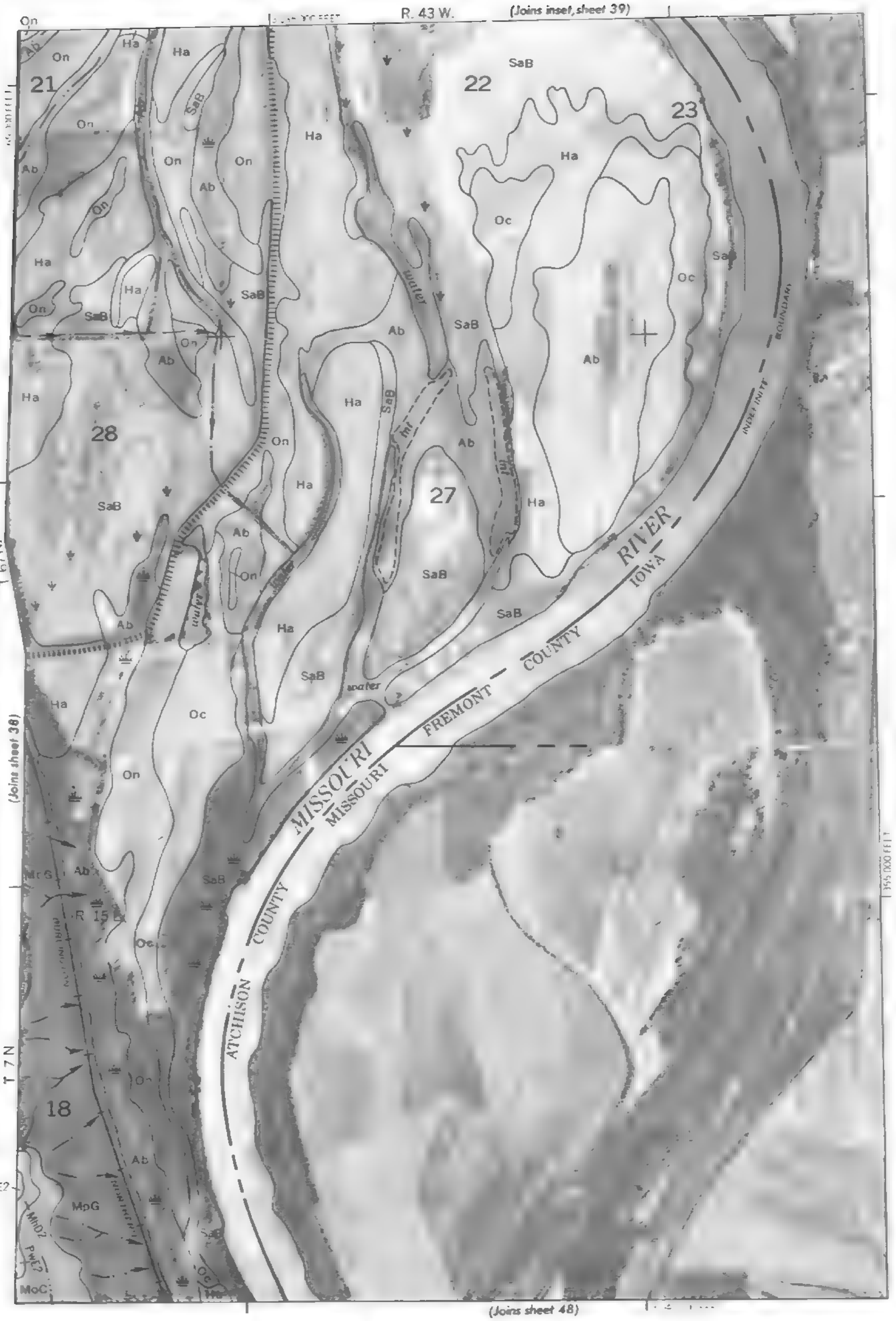

35
N
(Joins sheet 27)
(Joins sheet 36)
(Joins sheet 34)
(Joins sheet 44)
R. 12 E.
T. 7 N.
LITTLE
NEMAHA
RIVER
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
4000
5000
water

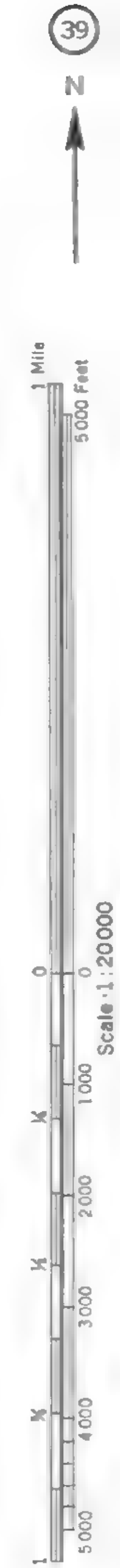
OTOE COUNTY, NEBRASKA — SHEET NUMBER 36



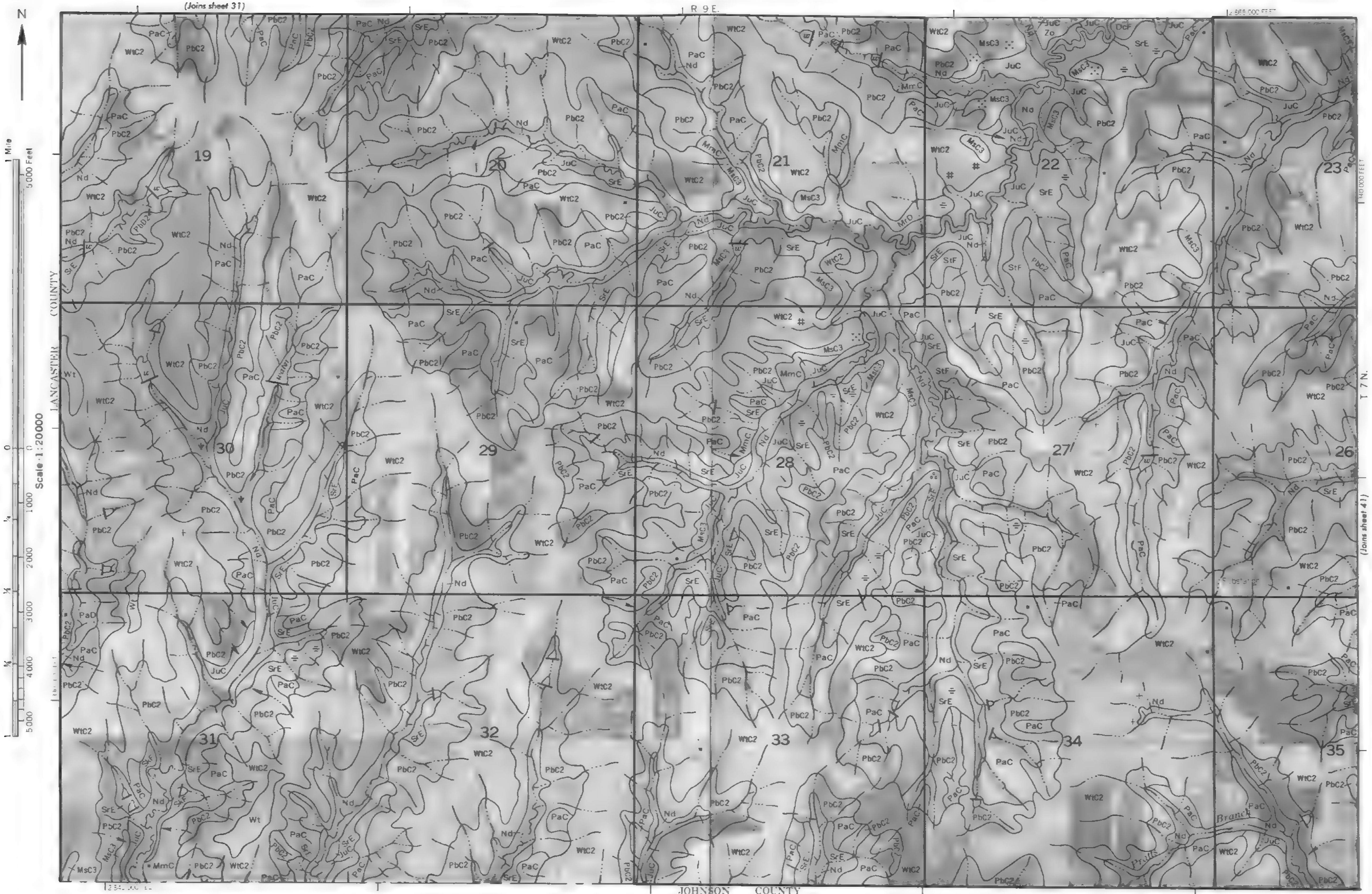

37
N
R. 13 E.
R. 14 E.
(Joins sheet 29)
(Joins sheet 36)
(Joins sheet 38)
(Joins sheet 46)
T 7 N
Paul
Rock
Creek
1 Mile
5000 Feet
Scale 1:20000

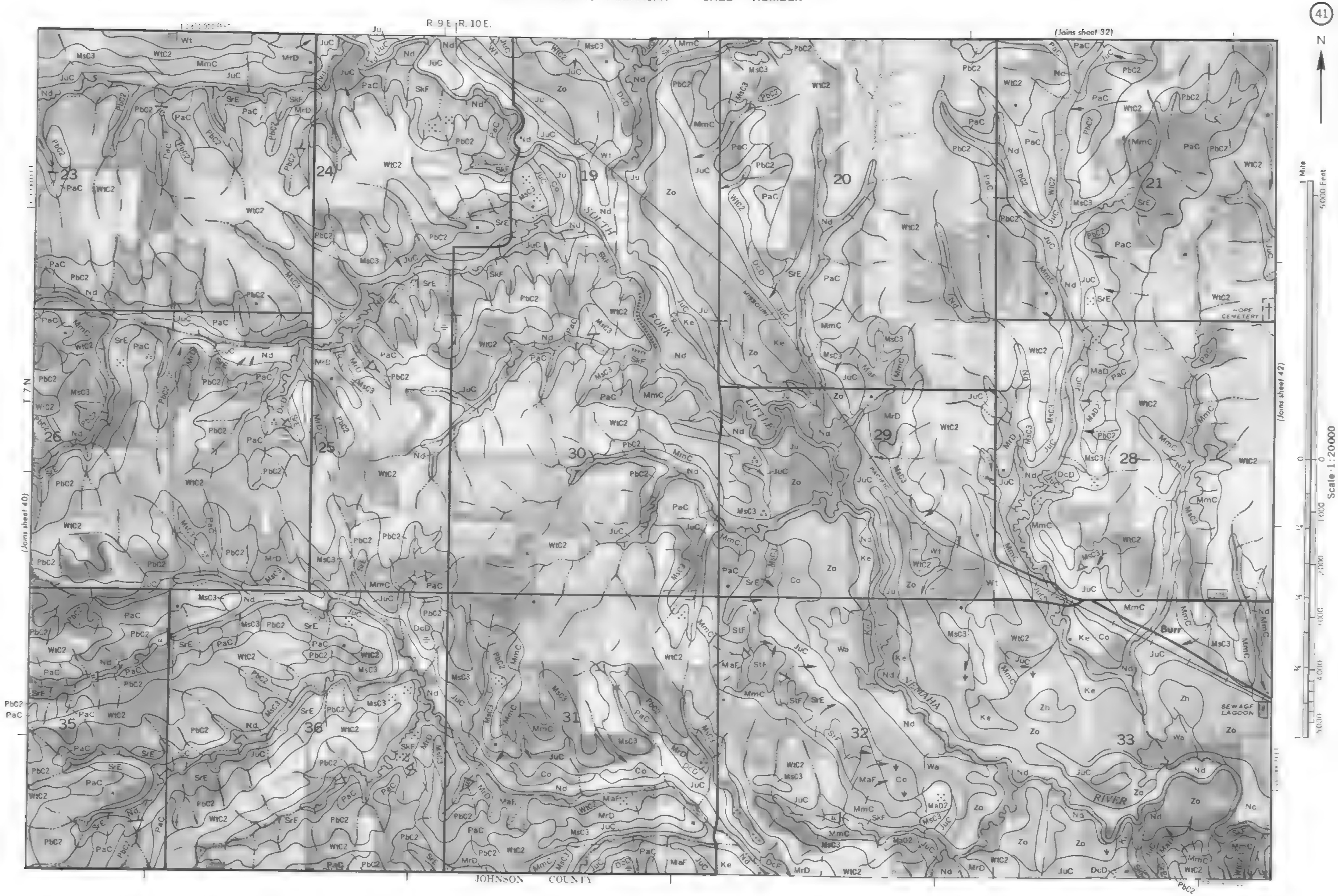

N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 30)
R 14 E
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 47)
T 7 N
Minerville
Camp Creek
North Branch
CAMP CEMETERY

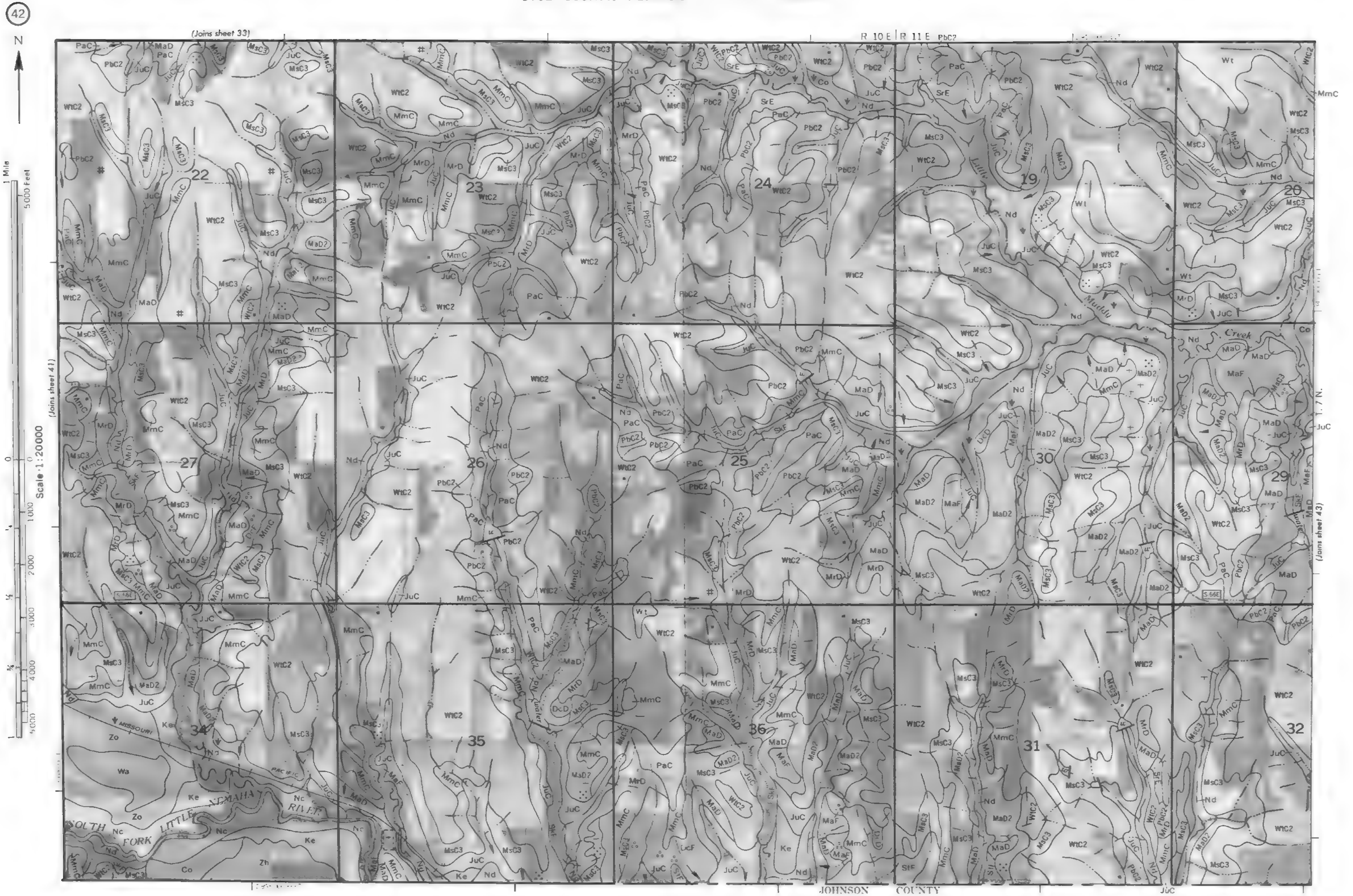


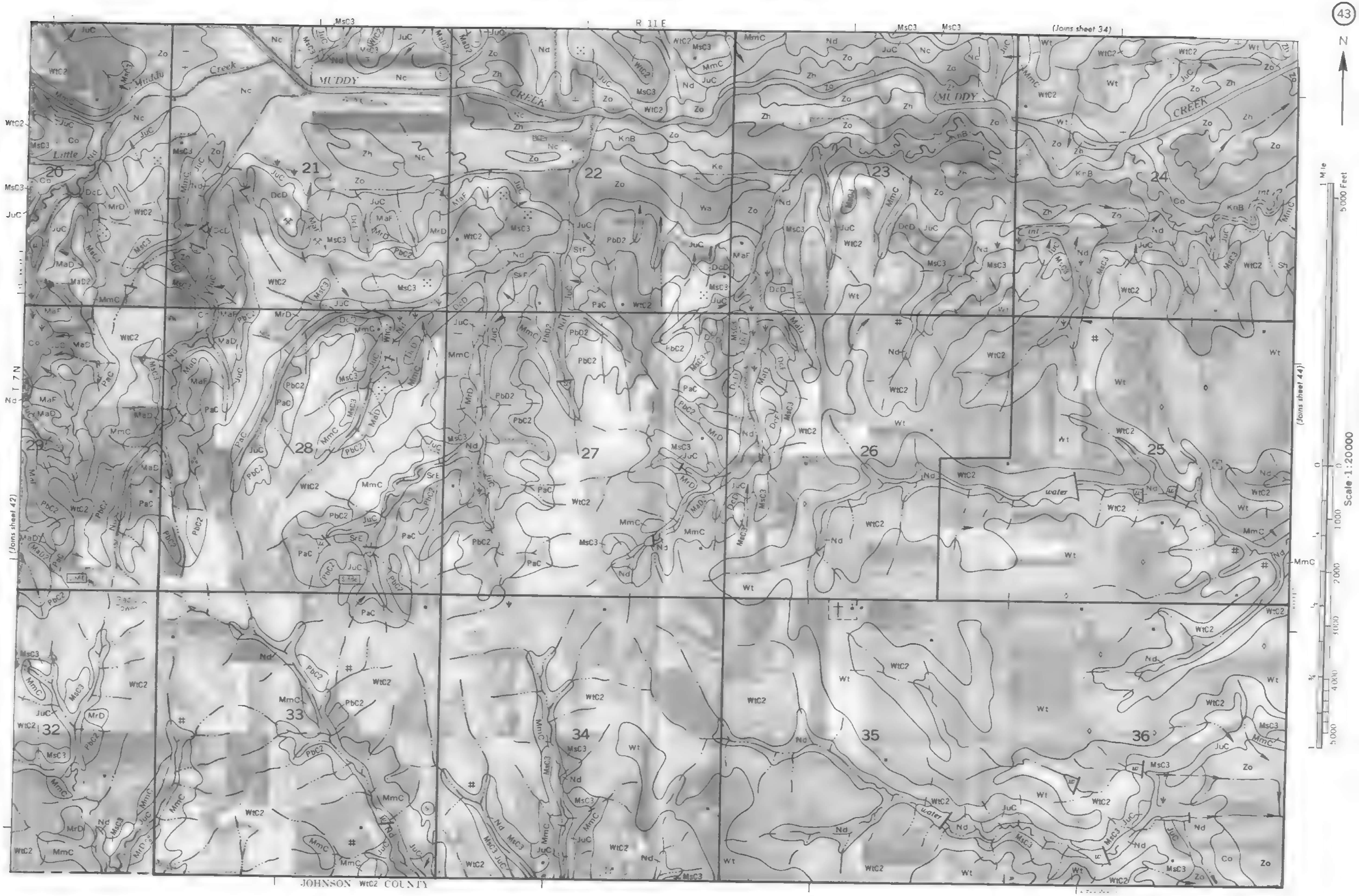


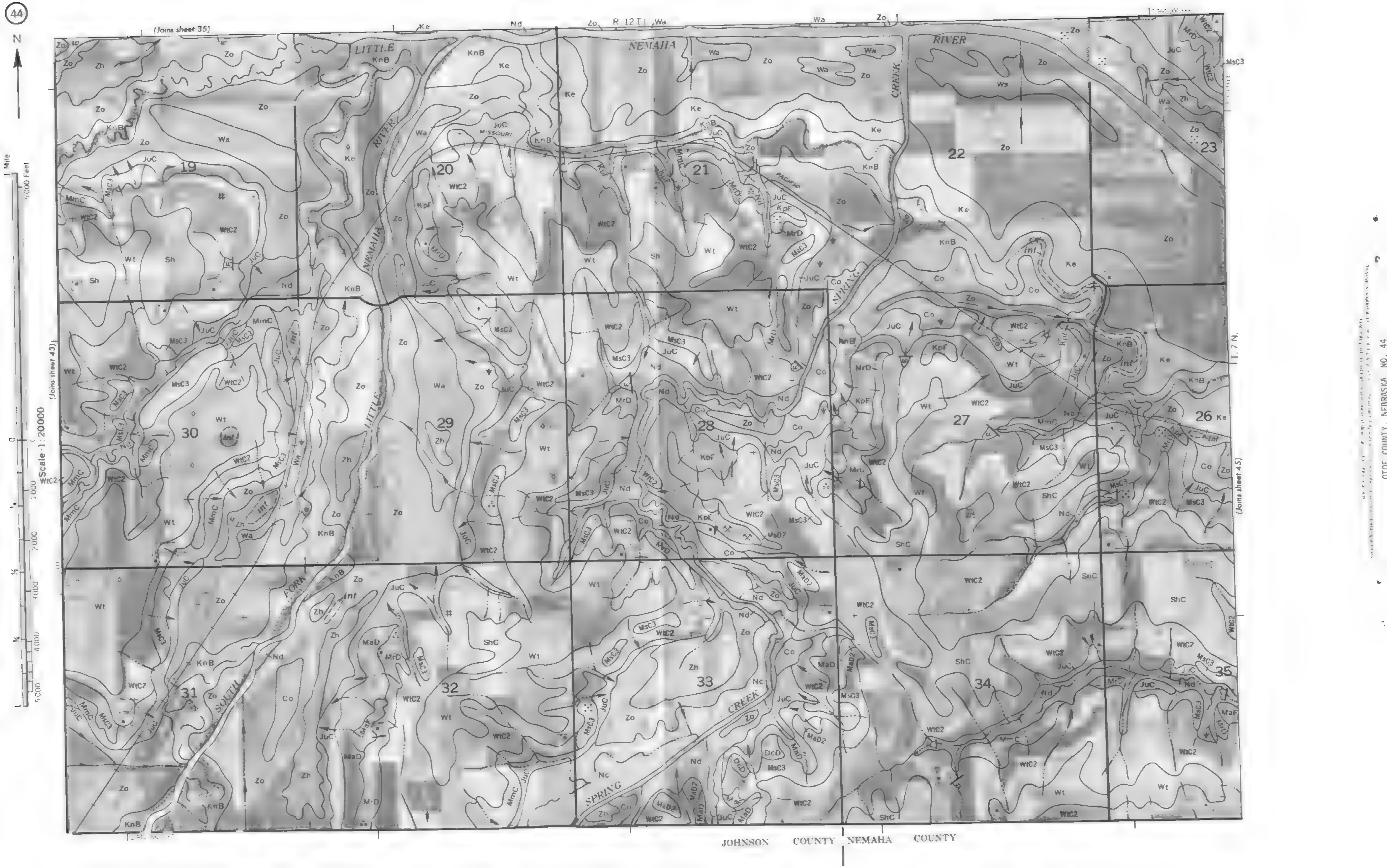
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

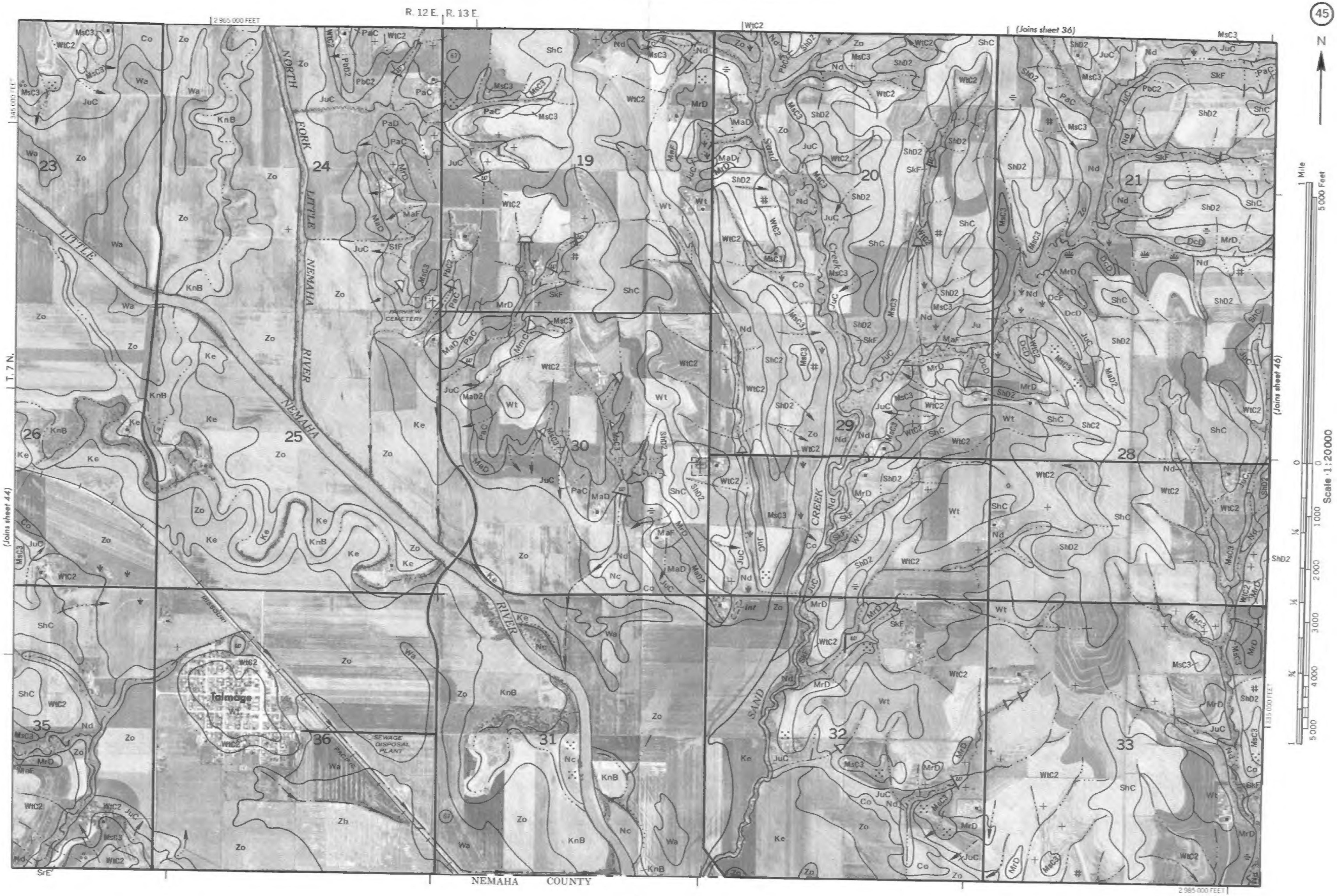

N
(Joins sheet 31)
R 9 E.
T 7 N.
(Joins sheet 41)
LANCASTER COUNTY
JOHNSON COUNTY
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
Branch


41
N
R. 9 E. | R. 10 E.
T. 7 N.
(Joins sheet 32)
(Joins sheet 40)
(Joins sheet 42)
SOUTH FORK
LITTLE NEMAHA RIVER
MISSOURI PACIFIC
HOPE CEMETERY
SEWAGE LAGOON
Burr
JOHNSON COUNTY
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33


42
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 33)
(Joins sheet 41)
(Joins sheet 43)
R 10 E | R 11 E
T. 7 N.
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Muddy Creek
SOUTH FORK LITTLE NEMAHA RIVER
MISSOURI PACIFIC
JOHNSON COUNTY

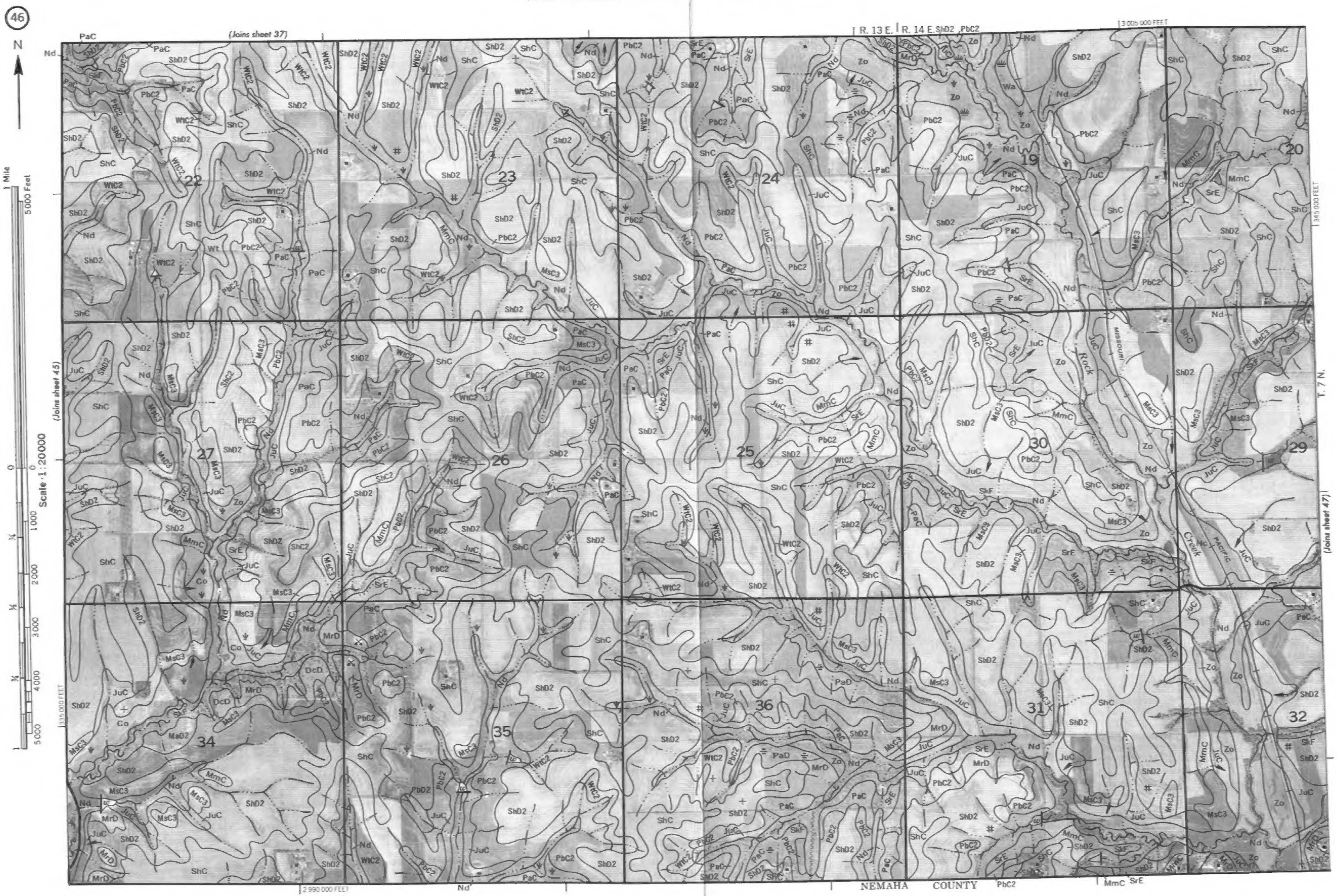

43
(Joins sheet 34)
R 11 E
T 7 N
(Joins sheet 42)
(Joins sheet 44)
MUDDY CREEK
Little
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
water
JOHNSON COUNTY
N
1 Mile
5000 Feet
Scale 1:20000


44
N
(Joins sheet 35)
(Joins sheet 43)
(Joins sheet 45)
R. 12 E.
T. 7 N.
LITTLE NEMAHA RIVER
NEMAHA RIVER
SPRING CREEK
LITTLE NEMAHA
SOUTH FORK
MISSOURI PACIFIC
Scale 1:20000
1 Mile
5000 Feet
JOHNSON COUNTY
NEMAHA COUNTY



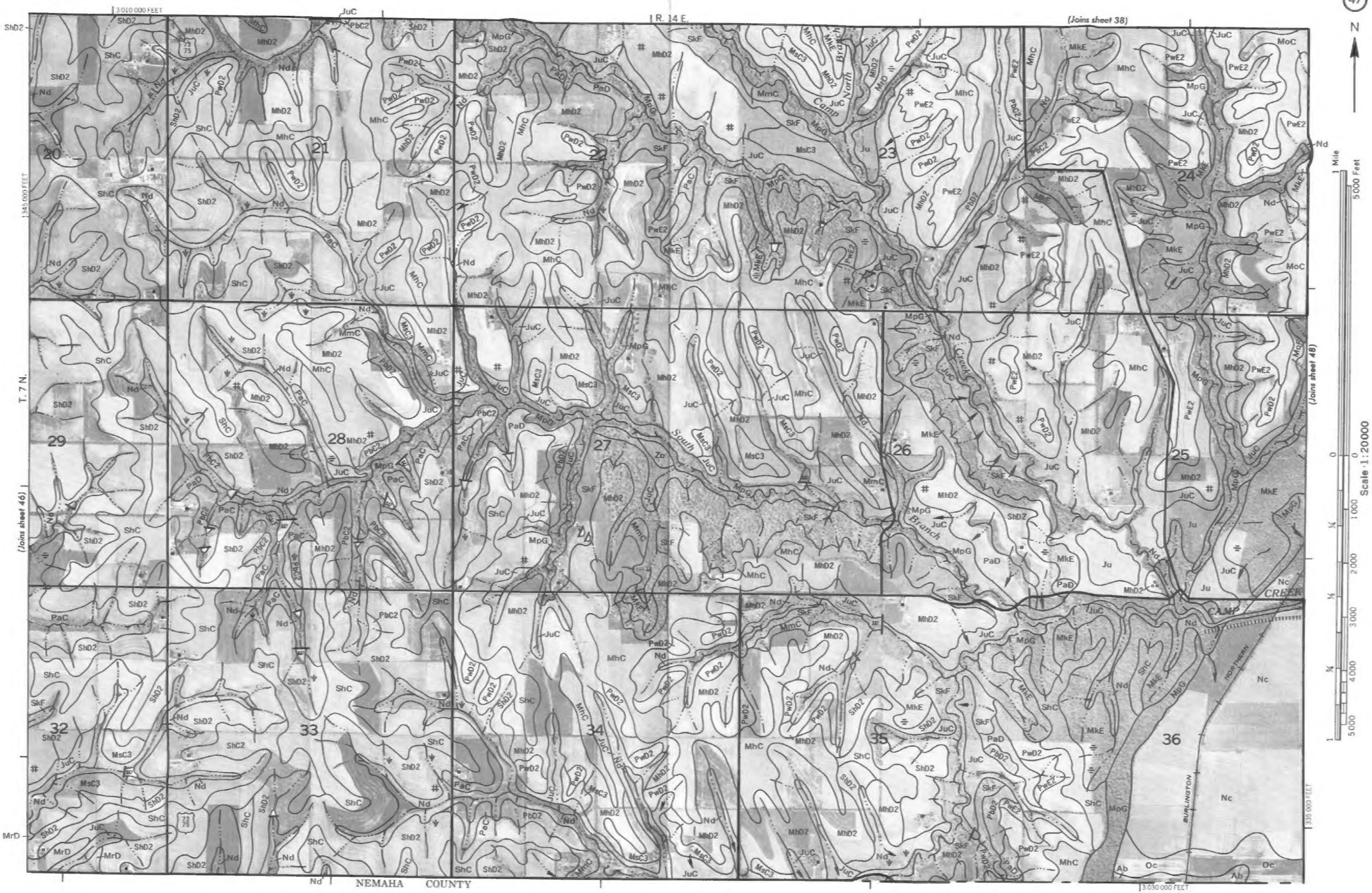
OTOE COUNTY, NEBRASKA NO. 45

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



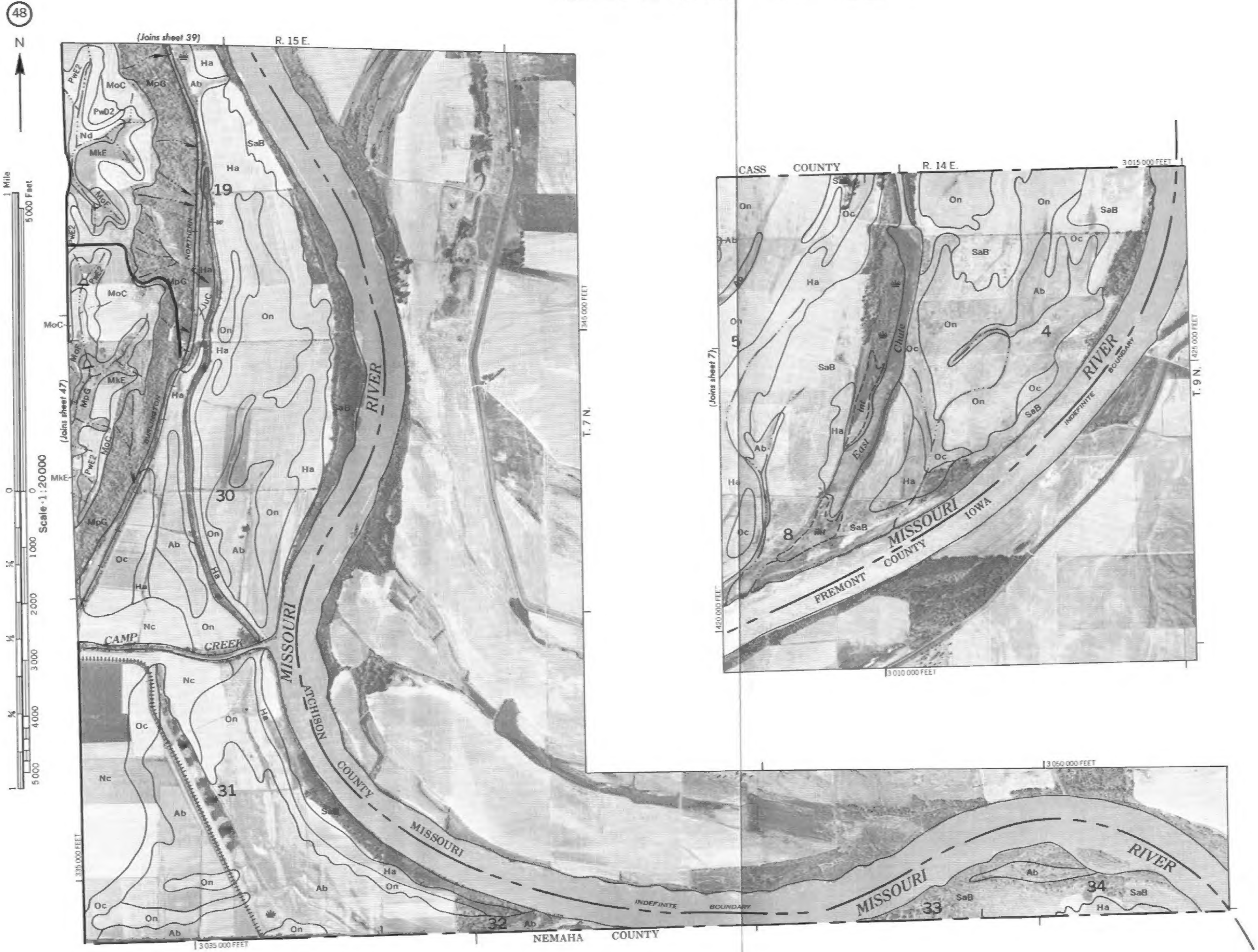
This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

OTOE COUNTY, NEBRASKA NO. 46



OTOE COUNTY, NEBRASKA NO. 47

This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



This map is compiled on 1973 aerial photography by the U. S. Department of Agriculture, Soil Conservation Service and cooperating agencies.
Coordinate grid ticks and land division corners, if shown, are approximately positioned.

OTOE COUNTY, NEBRASKA NO. 48